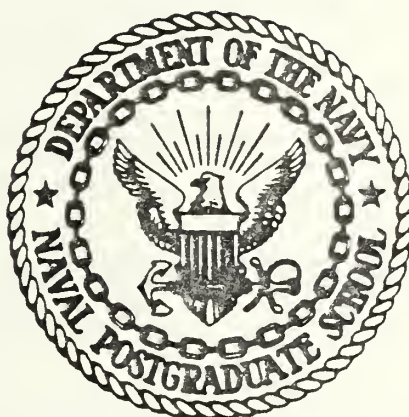


DESIGN STUDY OF A CENTERPLATE
MOUNT FOR WIND TUNNEL MODELS

Robert Wayne Russell

NAVAL POSTGRADUATE SCHOOL

Monterey, California



THESIS

Design Study of a Centerplate
Mount for Wind Tunnel Models

by

Robert Wayne Russell

June 1977

Thesis Advisor:

L. V. Schmidt

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installation of an alternate model support system using a centerplate mount was accomplished. An aerodynamic evaluation for comparing the two model mounting concepts was performed via experiments with a single calibration wing. Additionally, these experiments were the first operational exercise of a recently developed microprocessor data acquisition system.

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Design Study of a Centerplate
Mount for Wind Tunnel Models

by

Robert Wayne Russell
Lieutenant, United States Navy
B.S.A.E., Purdue University, 1971

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
June 1977

ABSTRACT

A three-strut wind-tunnel model support system was being used with an electrical balance in the 3.5 by 5.0 foot Department of Aeronautics low-speed wind tunnel. The traditional method of image systems and alternate inverted mounting for the evaluation of aerodynamic tares was considered impractical for implementation in the small sized tunnel. The design and installation of an alternate model support system using a centerplate mount was accomplished. An aerodynamic evaluation for comparing the two model mounting concepts was performed via experiments with a single calibration wing. Additionally, these experiments were the first operational exercise of a recently developed micro-processor data acquisition system.

TABLE OF CONTENTS

I.	INTRODUCTION	12
II.	MOUNT DESIGN CONSIDERATIONS	14
	A. THREE-STRUT MOUNT PROBLEM AREAS	14
	B. MODIFIED TASK MK I BALANCE LIMITATIONS	16
	C. TEST SECTION LIMITATIONS ON MODEL SIZE	20
	D. ALTERNATIVE MOUNT PROPOSALS	22
III.	MOUNT DESIGN	24
	A. TRADE-OFFS OF THE SELECTED CONFIGURATION	24
	B. MOUNT CONSTRUCTION FEATURES	27
	C. TUNNEL INTEGRATION	29
IV.	PROOF OF CONCEPT EXPERIMENT	33
	A. PRELIMINARY PREPARATION	33
	B. DESCRIPTION OF CALIBRATION WING	34
	C. THREE-STRUT MOUNTING SYSTEM EXPERIMENTS	35
	D. ADAPTATION OF CALIBRATION WING	36
	E. CENTERPLATE MOUNTING SYSTEM EXPERIMENTS	39
	F. THEORETICALLY EXPECTED RESULTS	39
V.	PRESENTATION OF DATA	43
VI.	CONCLUSIONS	62
	A. DATA ANALYSIS	62
	B. RECOMMENDATIONS	65
APPENDIX A		67
APPENDIX B		69
APPENDIX C		73

COMPUTER PROGRAMS-----	111
REFERENCES -----	112
INITIAL DISTRIBUTION LIST -----	113

LIST OF TABLES

<u>TABLE</u>	<u>CONTENT</u>	<u>MOUNT</u>	<u>Q(psf)</u>	<u>PAGE</u>
I.	Run Log			45
II.	Corrected Data, Run 051501	Three-strut	40	49
III.	Corrected Data, Run 051801	Three-strut	40	50
IV.	Corrected Data, Run 051802	Three-strut	30	51
V.	Corrected Data, Run 051803	Three-strut	20	52
VI.	Corrected Data, Run 052703	Centerplate	40	56
VII.	Aerodynamic Tares of Run 052703		40	57
VIII.	Corrected Data, Run 052702	Centerplate	30	58
IX.	Aerodynamic Tares of Run 052702		30	59
X.	Corrected Data, Run 052701	Centerplate	20	60
XI.	Aerodynamic Tares of Run 052701		20	61
XII.	Raw Data, Run 051501	Three-strut	40	75
XIII.	File Listing, Run 051501			76
XIV.	Raw Data, Weight Tare 051577	Three-strut	0	77
XV.	File Listing, Run 051577			78
XVI.	Raw Data, Run 051801	Three-strut	40	79
XVII.	File Listing, Run 051801			80
XVIII.	Raw Data, Run 051802	Three-strut	30	81
XIX.	File Listing, Run 051802			82
XX.	Raw Data, Run 051803	Three-strut	20	83
XXI.	File Listing, Run 051803			84
XXII.	Raw Data, Weight Tare 051877	Three-strut	0	85

<u>TABLE</u>	<u>CONTENT</u>	<u>MOUNT</u>	<u>Q(psf)</u>	<u>PAGE</u>
XXIII.	File Listing, Run 051877		40	86
XXIV.	Raw Data, Aero Tare Wing-Off Run 052602	Centerplate		87
XXV.	File Listing, Run 052602			88
XXVI.	Raw Data, Aero Tare Wing-Off Run 052603	Centerplate	30	89
XXVII.	File Listing, Run 052603			90
XXVIII.	Raw Data, Aero Tare Wing-Off Run 052601	Centerplate	20	91
XXIX.	File Listing, Run 052601			92
XXX.	Raw Data, Weight-Tare Wing-Off, Run 052677	Centerplate	0	93
XXXI.	File Listing, Run 052677			94
XXXII.	Raw Data, Wing-On, Run 052703	Centerplate	40	95
XXXIII.	File Listing, Run 052703			96
XXXIV.	Raw Data, Wing-On, Run 052702	Centerplate	30	97
XXXV.	File Listing, Run 052702			98
XXXVI.	Raw Data, Wing-On, Run 052701	Centerplate	20	99
XXXVII.	File Listing, Run 052701			100
XXXVIII.	Raw Data, Weight Tare, Run 052777	Centerplate	0	101
XXXIX.	File Listing, Run 052777			102

LIST OF FIGURES

1.	Three-strut mount and calibration wing -----	15
2.	Wing attach point detail -----	15
3.	Left side, modified Task MK I balance -----	17
4.	Right side, modified Task MK I balance -----	17
5.	Balance parallelogram geometry -----	19
6.	View of 3.5 x 5.0 test section -----	21
7.	View of sizing trade-offs -----	25
8.	View of centerplate installation -----	30
9.	Q calibration testing -----	30
10.	Q calibration curves -----	32
11.	Centerplate and bullet fairing, wing-off -----	38
12.	Centerplate and bullet fairing, wing-on -----	38
13.	Lift curve, three-strut mount -----	46
14.	Drag polar, three-strut mount -----	47
15.	Pitching moment curve, three-strut mount -----	48
16.	Lift curve, centerplate mount -----	53
17.	Drag polar, centerplate mount -----	54
18.	Pitching moment curve, centerplate mount -----	55
19.	Three-strut moment transfer relations -----	71
20.	Centerplate moment transfer relations -----	72

TABLE OF SYMBOLS

Latin Symbols

A.C.	Aerodynamic center
c	Wing chord ft
\bar{c}	Mean aerodynamic chord (MAC), ft
C_L	Centerline
C_D	Non-dimensional drag force coefficient = D/QS
C_L	Non-dimensional lift force coefficient = L/QS
C_M	Non-dimensional pitch moment coefficient = M/QSc
D	Drag force, lbs, positive in aft direction
L	Lift force, lbs, positive in up direction
M	Pitching moment, ft-lbs, positive in nose up direction
Q	Dynamic pressure, lbs/ft^2 (PSF), = $\frac{1}{2} \rho V^2$
R_N	Reynolds number, non-dimensional, for the wing = $\rho Vc/\mu$
S	Wing area, ft^2
V	Velocity, ft/sec, positive in downstream direction

Greek Symbols

α	Angle of attack (AOA), deg. or rad., positive in nose up direction
Δ	Change in position or specified variable, $\Delta()$
ρ	Density, slugs/ft^3
μ	Absolute viscosity, slugs/ft-sec
ν	Kinematic viscosity, $\text{ft}^2/\text{sec} = \mu/\rho$

Subscripts

$()_{\bar{c}/4}$	Variable referenced to 0.25 MAC
$()_o$	Variable evaluated at $C_L = 0$

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I. INTRODUCTION

The Department of Aeronautics at the Naval Postgraduate School (NPS) has seen limited low-speed wind-tunnel work in either its curricula or student research over the past several years despite housing several fine low-speed tunnels. The tunnel of primary interest was built to NPS specifications and design by West Coast Research. It offers an octagonal test section with 3.5 by 5.0 foot measurements and a maximum tunnel operating dynamic pressure (Q) of approximately 100 psf from its two-stage fan section. Although it is an excellent small tunnel, several factors have limited its use;

(1) Lack of modern, electronic balance capable of supplying analog voltage signals,

(2) Lack of a data acquisition system to convert analog voltage into convenient digital form,

(3) Lack of a potential computer program for the calculation of wall correction factors for an arbitrary wing configuration, and

(4) Lack of a flexible mounting system that would ease model construction, allow rapid model or configuration changes, and enable measurement of aerodynamic tares.

Recently, an improvement program has been initiated to correct the limiting factors with the objective of producing an integrated tunnel system. Work documented by Concannon in

Ref. 1 has removed factor one. Current work by Casko, Ref. 2, and Heard, Ref. 3, is projected to remove factors two and three, respectively. This thesis is a design study for a solution to factor four, namely, the development of an improved model mounting system. It is important to note the balance system lends itself to three-component longitudinal airframe data, only. Downstream planning is needed to acquire a full six-component balance facility capable of yielding aerodynamic information at both angle of attack and sideslip.

Completion of the integrated system should provide a modern, highly automated tunnel system, readily adaptable to various demands and capable of generating accurate airframe data suitable for engineering analysis.

II. MOUNT DESIGN CONSIDERATIONS

A. THREE-STRUT MOUNT PROBLEM AREAS

The three-strut mount has traditionally found great favor in low-speed wind tunnels for testing conventionally configured, nonaeroelastic models. As seen in figure 1, the three-strut mount consists of two main struts supporting the wing at two wing station attachment points, and a third strut attached to an aft tail sting. This type of mount is sufficiently rigid and offers ease of angle of attack variation, as pointed out on pg. 149 in Ref. 4. For larger low-speed tunnels, drag tare and interference evaluation is possible; however, the three-strut model support system is quite complex in this regard. Small tunnel size compounds the problem and most academic tunnels forego the evaluation of aerodynamic tares.

Exposed struts contribute a drag tare and/or a pitching moment variation in the case of the aft strut. Partial compensation is possible through the use of strut fairings or windshields over some of the exposed struts. Strut to fairing interference, though present, is usually negligible in small tunnels. A more serious interference effect is that of the wing strut and fairing on the wing, inducing unknown flow disturbances onto the wing's flow field.

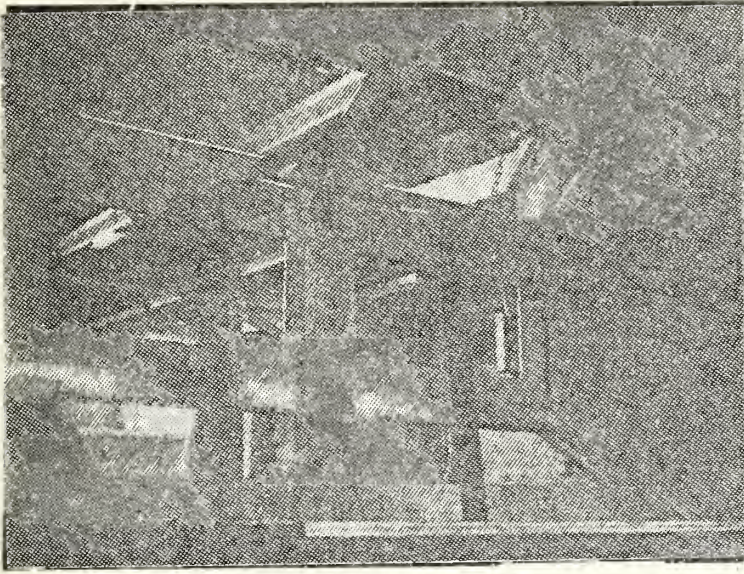
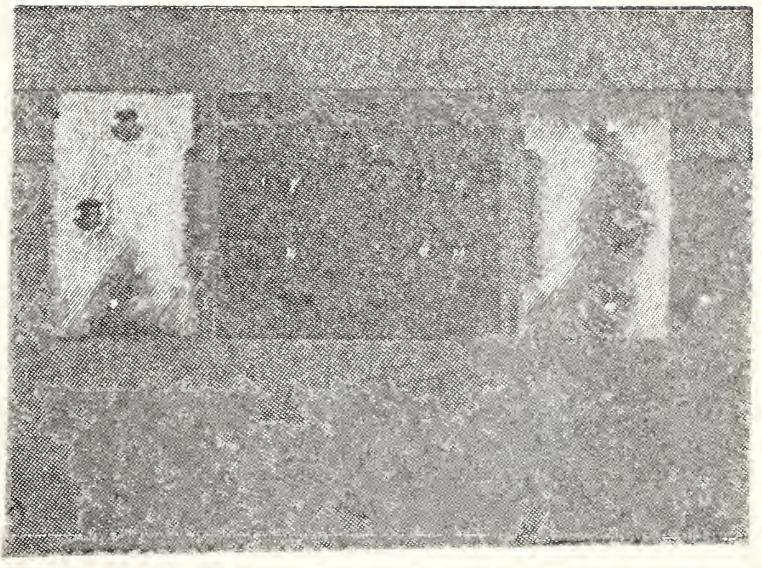


Figure 1. Three-strut
mount and calibration
wing.

Figure 2. Wing attach
point detail.



Techniques for the evaluation of this effect are documented in the literature and utilize a procedure involving an image system and alternate inverted mounting; cf, pp. 175-180, Ref. 4. Figure 2 depicts the requirement for extremely fine image detail and model hardware to facilitate this scheme. The investment in time and detail is usually by-passed in small tunnels because of the small absolute size of the correction sought and the inherent resolution of the balance system employed. The third strut varies the angle of attack, and it is reasonable to assume that an unfaired strut will contribute drag and pitching moment tares as a function of angle of attack. Elaborate, variable fairings have been devised to keep the exposed portion of the aft strut constant in some large tunnels, but aft struts are generally unfaired in small tunnels. Additionally, wing attachment points preclude model experiments for investigating aeroelastic effects. A mounting system which would relax the above restrictions within the limitations of the tunnel balance and test section area was required.

B. MODIFIED TASK MK I BALANCE LIMITATIONS

The Department of Aeronautics acquired a Task Corporation MK I balance in 1958. The balance was a standard, three-component beam balance capable of lift, drag and pitching moment measurements. In Ref. 1 Concannon describes modifications made to the balance to provide electrical strain gage

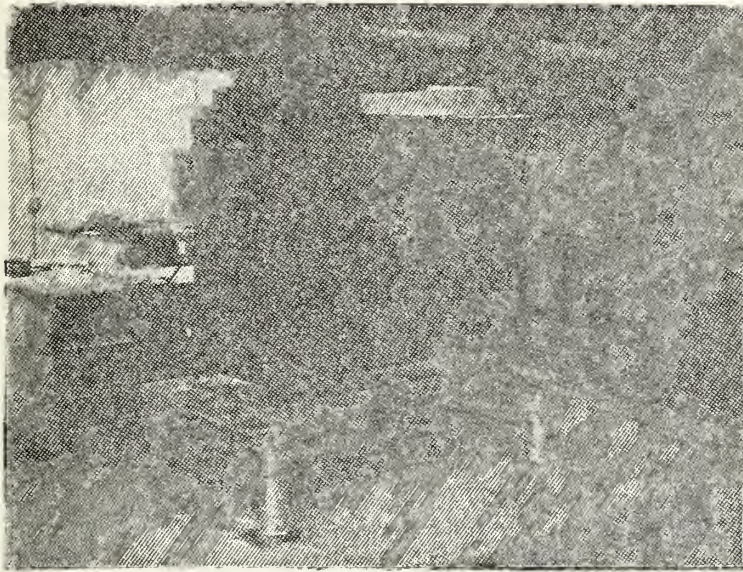


Figure 3. Left side
modified Task MK I
balance.

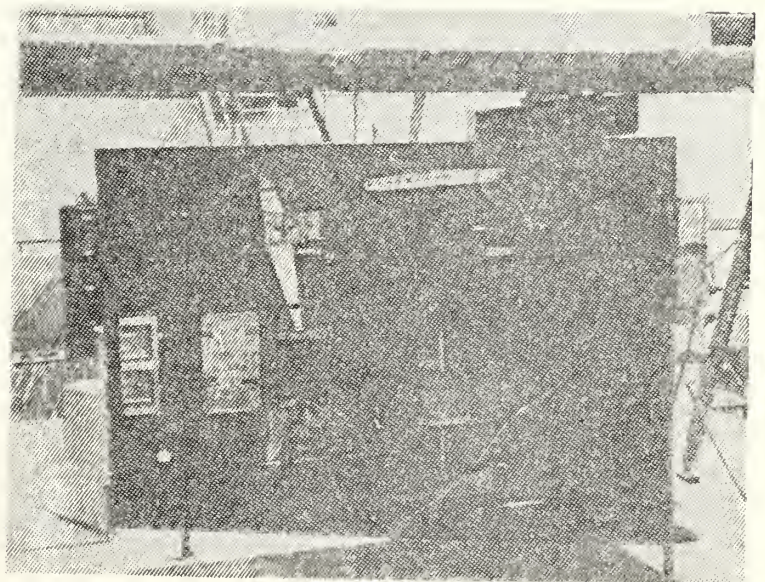


Figure 4. Right side,
modified Task MK I
balance.

outputs, thereby upgrading its potential as an element of a modern data acquisition system. Figures 3 and 4 show the Task balance in its modified configuration.

Adoption of strain gage measurement imposes linear response load ranges. Concannon selected these ranges as;

\pm 500 lbs. in lift,

\pm 75 lbs. in drag, and

\pm 75 ft.-lbs. in pitching moment

These values were taken as the expected maximum working loads for the proposed mount.

Figure 4 depicts the large cross beam for main strut support and a small aft lever arm for varying angle of attack via a tail strut. As would be supposed, the balance was designed for a three-strut mount shown previously in figure 1. The provisions for main beam support and aft angle of attack drive had to be incorporated in the proposed design.

The balance is also configured so that the geometry of a parallelogram had to be established and maintained for constant one-to-one angle of attack tracking. Figure 5 depicts the relationship between the lever arm pivot, main trunnion and aft pins. This was a primary consideration for the design of an alternate mount.

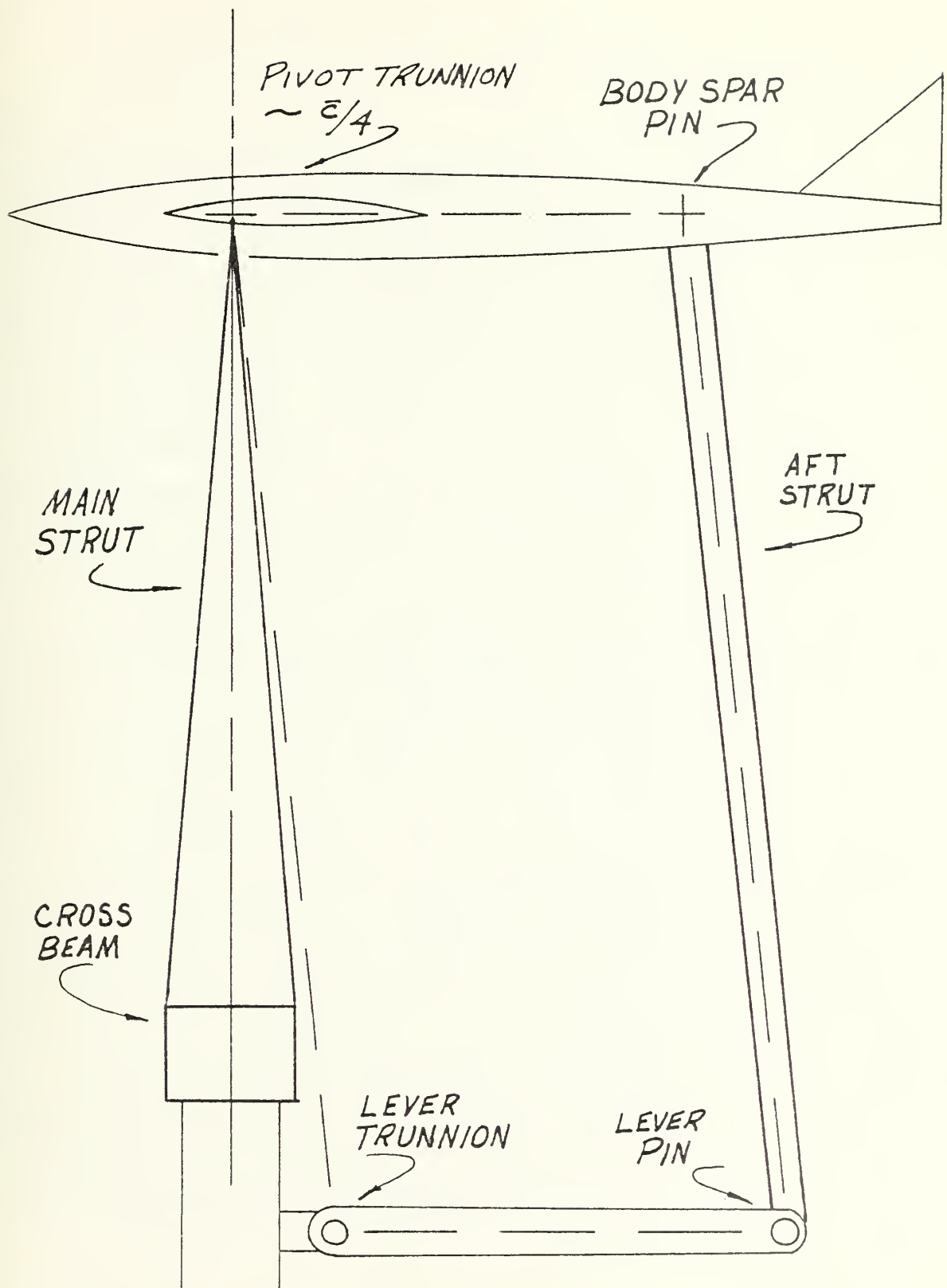


Figure 5. Balance parallelogram geometry.

C. TEST SECTION LIMITATIONS ON MODEL SIZE

The primary NPS low-speed tunnel offers a 3.5 by 5.0 foot test section with 20-inch fillets forming an octagonal cross-section as seen in figure 6. The main limitations imposed by test section size are the model span and a trade-off between tail/canard moment arm and geometric angle of attack. The general rule of thumb for span is that it should be no more than 80% of the test section width. This yields a maximum span of four feet with six-inch tip clearance. Maximum moment arm is a function of maximum angle of attack and the allowable proximity of the tail or canard to a tunnel wall. A minimum six-inch clearance for the tail A.C. at maximum angle of attack was assumed for design purposes. The reason for the clearance requirement is the breakdown of potentially derived or empirically estimated wall corrections in the turbulent boundary layer.

A span of four feet and an aspect ratio of six yields a chord of 0.677 feet for a straight untapered wing. At standard sea level conditions and a Q of 60 psf, a Reynolds number of 950,000 resulted. Maximum tunnel Q , 100 psf, would only increase the Reynolds number to 1,250,000. These Reynolds number values are low for testing in the turbulent regime without some form of boundary layer tripping. Small aspect ratios and larger chords for the four-foot span would improve the situation, but low Reynolds numbers still represent a penalty inherent in small tunnels. For this reason tunnels

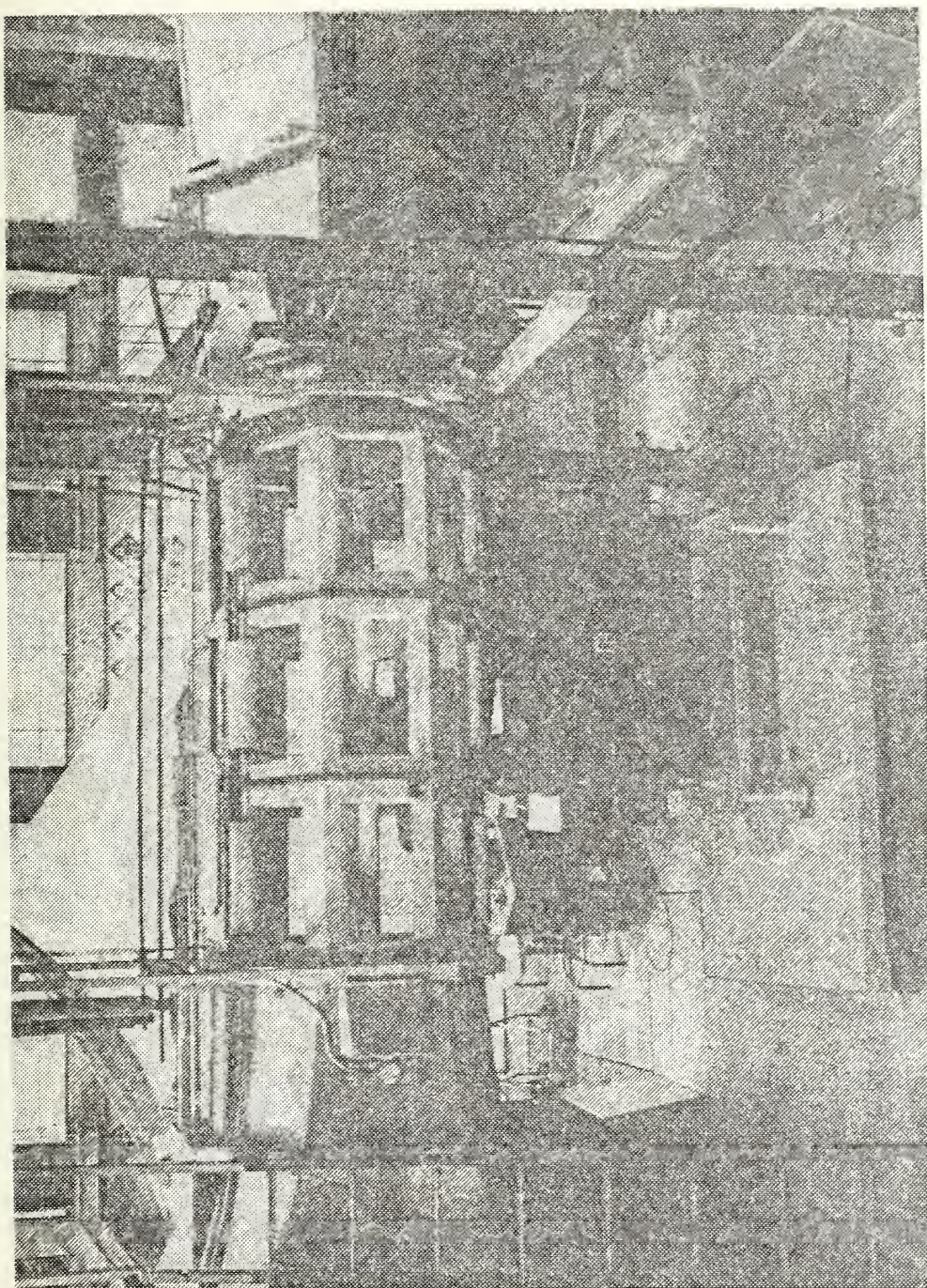


Figure 6. View of 3.5 x 5.0 test section.

of the 3.5 by 5.0 foot size represent those used primarily for academic purposes or for work where Reynolds number scaling is of lesser importance.

Test section size also affects the amount of deviation from the centerline that is negligible, and the allowable solid blockage by the mount. Of course, it is best to keep both to a minimum, but they are generally not driving concerns, providing tunnel flow calibrations are accurate and the velocity profile is well developed and uniform.

D. ALTERNATE MOUNT PROPOSALS

Several mount configurations were proposed as solutions to the problem outlined in part A and the compatibility constraints listed in parts B and C. Balance limitation to three-component measurements considerably eased the problem of achieving sufficient lateral-directional rigidity. Minimum mount complexity and interference with the primary aerodynamic surfaces was sought. These goals indicated a reduction in the number of struts, removal of the attach points from the wing and a design that could be adapted to the measurement of aerodynamic tares. Candidate proposals then included the single strut, tandem struts, centerplate and tail sting mounts.

The single strut mount is the simplest and keeps interference to a minimum but is weak in torsion and concentrates the stresses at a single attach point under the fuselage of

a model. A fairly large strut width is required to provide sufficient rigidity and reasonable stress levels at design loads.

The tandem strut arrangement appeared to add no benefits at the cost of added complexity, but again, interference would be near minimum.

The centerplate mount represented what could be considered a continuous compromise of the previous two mount proposals. It would require only a single fairing, and the plate could fit in a slot along the under side of a model's fuselage. It seemed apparent that this mount would distribute the attachment forces more evenly, and that the detail of single point attachment would be eliminated. Width was traded for length, and the question of interference increase remained to be answered.

Tail sting mounting was the final consideration. Although it offered the least interference and nil blockage, the mount is optimized for single jet models in a high-speed tunnel. Limited angle of attack variation was another constraint of this type. A more complex adaptation for angle of attack drive would also be required.

Centerplate mounting appeared the most promising, and it was felt that the questioned increase in interference over the single strut mount would be negligible, if any. This approach was selected, and further design considerations are addressed in subsequent sections.

III. MOUNT DESIGN

A. CENTERPLATE CONFIGURATION TRADE-OFFS

After selection of the centerplate as the most promising design, several immediate engineering decisions were required to fix mount geometry. Since the mount would be expected to test a wide variety of models and wing types, a -15° to plus $+30^{\circ}$ angle of attack range was arbitrarily selected. The location of the plate trunnion about which the plate would describe a circular arc was a primary consideration. Selection of the arc radius with the plate at zero angle of attack fixes the trunnion location vertically below the test section centerline. Further considerations on this radius length were the tail-to-wall proximity at maximum angle of attack for a representative tail moment arm, 25 inches assumed, and the amount of fairing blockage required to shield the main support. Minimum radius length improves the former but is inverse for the latter. As stated previously, a minimum wall clearance of six inches for all aerodynamic surfaces was desired. A small radius also favors minimum deviation from test section centerline, but then incurs the possibility of interference by the proximity of the fairing. The trade-off considerations are depicted in figure 7.

Rough plots of various parameters as a function of arc radius were constructed and an engineering judgment on a 14-inch radius was made.

The basic mount geometry was thus fixed. For an A.C. on the test section centerline and balance focal point when $\alpha = 0^\circ$, its vertical deviation is -0.48 inches and the longitudinal deviation is ± 3.62 inches for $\alpha = \pm 15^\circ$. The maximum vertical deviation is -1.88 inches and the maximum longitudinal deviations are +3.62 inches forward/-7.00 inches aft respectively for the design condition $\alpha = -15^\circ, +30^\circ$. Vertical deviation in the $\pm 15^\circ$ case is 1.1% of tunnel height vs. 4.5% for the maximum $+30^\circ$ condition. It should be noted that the vertical displacement represents the only increase of tail/canard proximity compared to a three-strut mount pivoting about an axis through the centerline. These were considered acceptable for well developed, tunnel flow profiles. By mounting the wing above the plate's upper surface, maximum deviation of the A.C. can be reduced since the total variation could be made to center about the test section centerline in addition to the option of providing a desired design model angle condition on the test section centerline.

Plate length was selected as twenty inches, ten inches on each side of the vertical centerline when the plate is at $\alpha = 0^\circ$. This represented a trade-off between model fuselage slot length, fairing length and lateral-directional rigidity. A fuselage spar was predicted to give added directional rigidity, and so a sizeable 20-inch width was selected to improve its torsional bending resistance for a given thickness.

B. MOUNT CONSTRUCTION FEATURES

Having fixed centerplate geometry, the detailed design work remained. Simplicity, strength and rigidity were the primary design goals. A design safety factor of ten over yield for the most critical combination of maximum working loads outlined in section II, part B, indicates the emphasis on eliminating structural deformations.

A single stainless steel support with a vertical fork to accept the centerplate was adopted. A one-half inch diameter steel trunnion pin installed with an interference fit to the aluminum centerplate was supported in journal bearings of the flanking doublers. Plate thickness was selected as three-eighths inch, with twin three-sixteenth inch doublers below the level of the fairing.

The left fork of the main support was designed to be removable for initial installation of the centerplate assembly and for later adaptation or modification as desired. The plate was attached with four $1/4$ - 20 cap screws and trued by two alignment pins.

The main support was directly attached to the Task balance by $1/4$ - 20 cap screws and a backing plate. The bottom of the support was submerged five inches below the level of the tunnel floor. The remainder of the support and lower third of the centerplate incorporated a fairing for smooth flow and minimal interference.

The fairing consists of wooden, contoured leading and trailing edges, an angle frame of aluminum and two removable aluminum side plates. Close attention was paid to fairing aerodynamics to minimize cross flow separation at the leading edge and adverse pressure gradient separation at the trailing edge. A slot was milled into the upper cap to allow approximately one-sixteenth inch clearance for the centerplate. The entire fairing was to be mounted on a three-quarter inch plywood tunnel floor. The old flooring was retained to accommodate the original three-strut mount, if some unforeseen requirement for it should arise. The fairing was 12.5 inches high with a cross-section of 27.45 square inches. This represents a blockage factor of 1.31% for the tunnel test section. The resulting blockage appeared to be acceptable, and a tunnel Q calibration was performed with plate fairing installed.

The angle of attack was varied by a strut attached to the aft end of the centerplate and submerged under the fairing. An adjustable turnbuckle was incorporated to provide precise parallelogram alignment for proper angle of attack tracking.

The entire mount was fabricated to the specification of the author by the craftsmen of the Department of Aeronautics model shop from readily available materials. Critical part tolerance met or exceeded 0.002 inches.

C. TUNNEL INTEGRATION

The original three-strut mount was removed after the collection of baseline data. The three-quarter inch plywood flooring was removed to keep the three-strut system intact. Then, the main support was checked on the main beam of the balance to insure correct fit. A new one-piece plywood floor was fabricated and mated to the test section framework. The fairing was then fastened along the test section centerline. The fairing sides were removed, and the centerplate was installed (see figure 8). The aft strut was adjusted, and the angle of attack was trued. The angle of attack was checked by a precision inclinometer throughout the design range of the mount, and found to be accurate within one second of arc. Concurrently, a check was made to ensure proper clearances of the plate, main support and aft strut. Rolling moments were applied to the plate to ensure minimal torsional deflection and to confirm that plate and fairing slot interference would not occur. An interference light was rigged with a series circuit between the balance and fairing. Subsequent runs indicated no fairing interference and that torsional rigidity was not a factor at the highest Q tested for a representative wing, 50 psf. Some minor alterations to the fairing framework were made to improve access to the main support side plate, but no major problems were encountered in the installation phase.

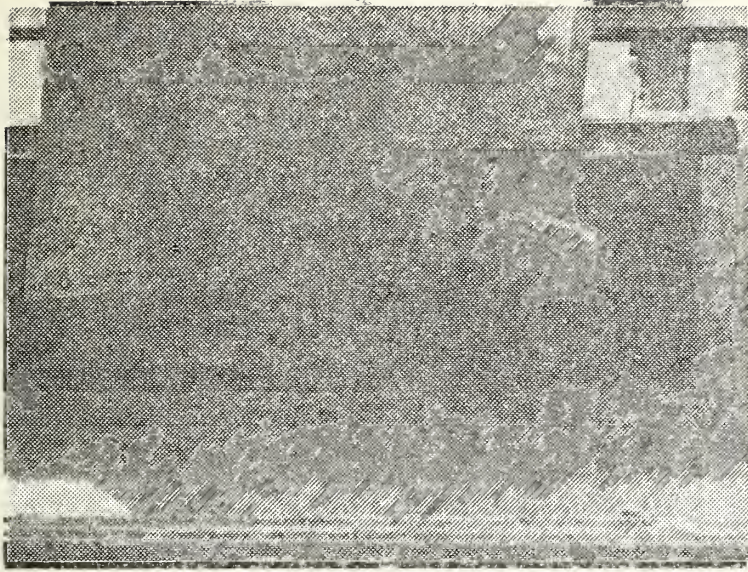


Figure 8. View of
centerplate
installation

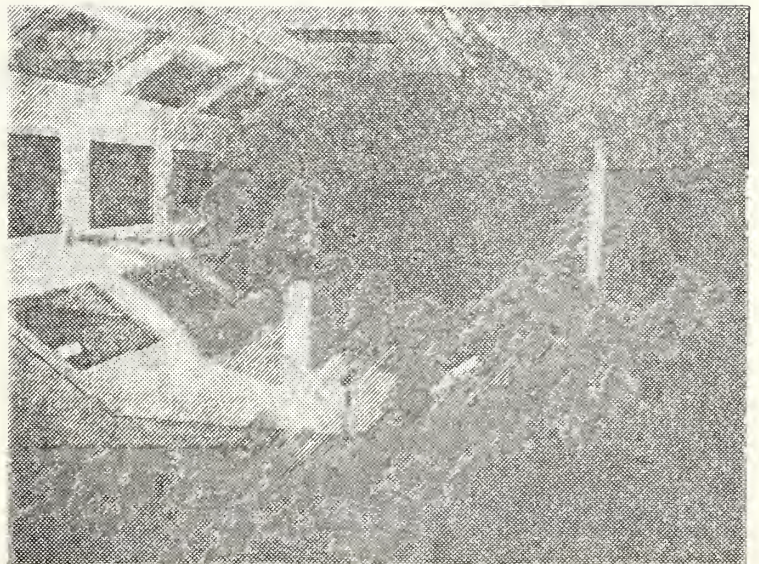


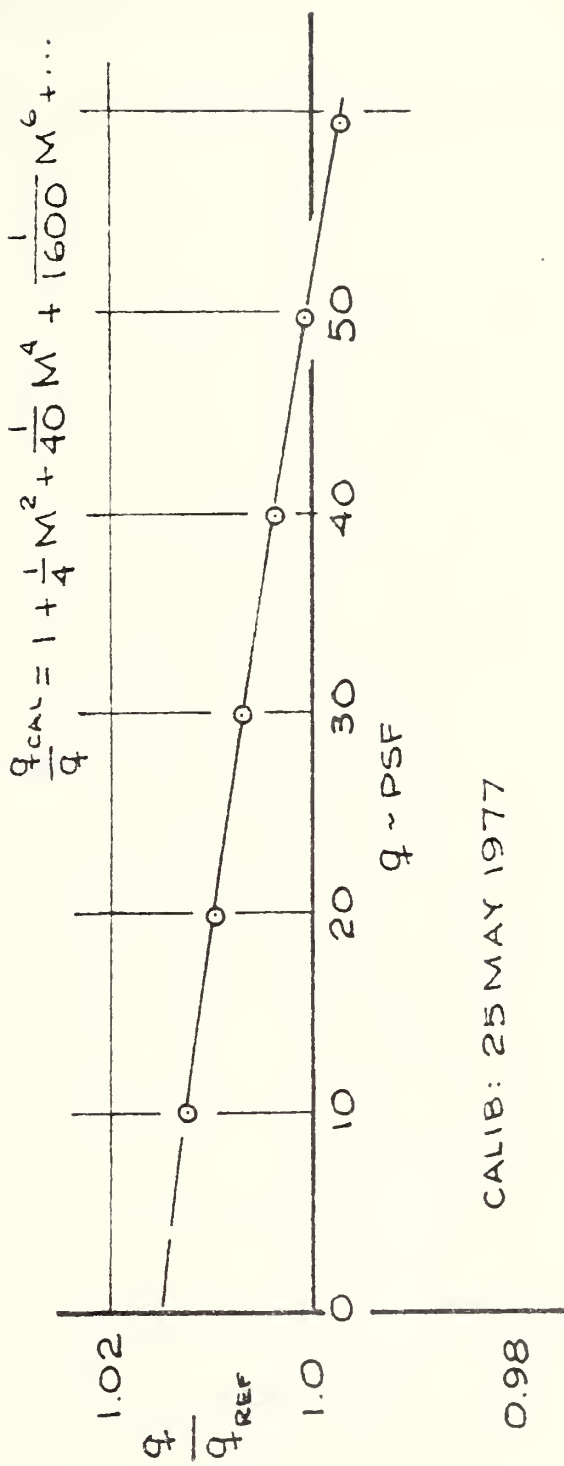
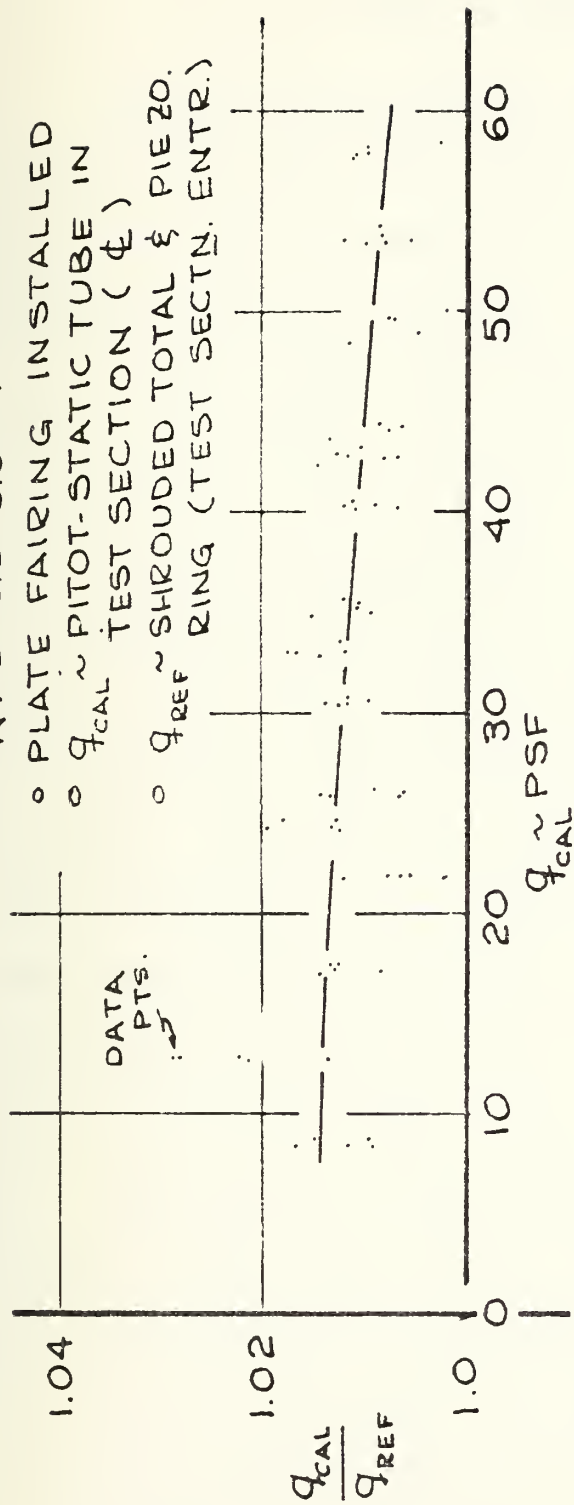
Figure 9. Q calibration
testing.

Once installed, a dynamic pressure calibration was performed to account for the revised tunnel configuration, including the centerplate fairing (see figure 9). The procedure was to take readings of a shrouded total pressure, a piezo ring static pressure, and a pitot-static tube which included total Q and static pressure measured over the fairing on the tunnel centerline. The first two pressure sources combine to yield a reference Q , Q_{ref} , while the last two pressures establish the Q to be calibrated, Q_{cal} .

Initially, an attempt to measure these values was made with a scanivalve; however, tunnel turbulence and the time delay of manual switching between data channels produced widely scattered data. At this point the power of the data acquisition system was utilized, and it was reprogrammed to scan each pressure transducer 128 times during a two-second time frame and numerically average the sample readings. The resulting scatter was noticeably reduced. Further refinement of the Q readings was made by incorporation of the subsonic pitot-static correction for compressibility effects [Ref. 5]. For Q 's available to the low-speed tunnel, errors on the order of 1.0% could occur if the Mach correction were not taken into account. A summary of this Q correction is presented in figure 10.

NPS 3.5x5.0 FT. TUNNEL

- PLATE FAIRING INSTALLED
- $q_{CAL} \sim$ PITOT-STATIC TUBE IN TEST SECTION (Φ)
- $q_{REF} \sim$ SHROUDED TOTAL & PIEZO. RING (TEST SECTN. ENTR.)



CALIB: 25 MAY 1977

Figure 10. Q calibration curves.

IV. PROOF OF CONCEPT EXPERIMENT

During the time period when the plate mount system was being fabricated, experiments were initiated to provide baseline data suitable for verification of the plate mount concept using an existing calibration wing. An added goal of the test sequence was the proof testing under actual laboratory conditions of the microprocessor oriented data acquisition system developed independently by Casco (Ref. 2). Initial testing, after modification of the Task MK I balance, indicated that inaccuracies were present due to the unavailability of the aerodynamic tares and the interference inherent when testing with a three-strut model support system. The accurately constructed calibration wing, which was available for the three-strut mount tests (see Figure 1), was subsequently adapted for comparable experiments upon the plate mounting system.

A. PRELIMINARY PREPARATION

The signal conditioning amplifiers used by Concannon (Ref. 1) when acquiring his reported strain gage calibrations were rebuilt by the Department of Aeronautics for the express purpose of making possible improved electronic interfacing with the new data acquisition system. Therefore, a more current set of calibration matrix constants had to be determined. This was performed with a static loading frame and

calibration weights on the three-strut mounting system while installed in the tunnel test section. Following procedures outlined by Concannon in Ref. 1, the balance was calibrated to resolve lift force, drag force and pitching moment relative to a lateral axis through the intersection of the main strut trunnion axis and the vertical centerline of the balance cross beam. It is important to note that the accurate resolution of forces and moments about this axis (the virtual center or focal point of the balance) is independent of the type of support mount used, and any offset of a desired model reference point requires a moment transfer. Numerical values for the correlated reduction matrix constants may be found in Appendix A.

It should also be noted that the first stage fan blades were removed from the tunnel for refurbishing prior to the course of these experiments, which in turn effectively limited the tunnel test section operating dynamic pressure (Q) to approximately 55 pounds per square foot (psf). No advantage was seen in pushing the single stage fan to its limit, hence a dynamic pressure range of 20 to 40 psf was selected for test purposes.

B. DESCRIPTION OF CALIBRATION WING

The calibration wing available for the experiment had a modified NACA 63-010 airfoil, constant over a three-foot span. The wing was without taper or twist, and had a six-inch chord. The rectangular wing tip sections were adapted

from NACA 63-015 contours. The wing attached to the main struts of the three-point mount at two wing trunnions located six inches on either side of the longitudinal axis, and coincident with the quarter-chord line. A thin steel sting attached to the wing spar and trailed aft to the tail strut pin attachment point. Sting width in the airfoil section was 0.50 inches, and it was filleted to 0.25 inches from the wing trailing edge to the aft tail strut clevis pin region. The sting moment arm for the three-strut mount was 15.00 inches.

C. THREE-STRUT MOUNTING SYSTEM EXPERIMENTS

The objective of the three-strut mount experiments was to document accurately the performance of the calibration wing upon this type of support system without aerodynamic tare estimations being applied. The main struts were carefully faired by individual windshields to within approximately four inches of the wing surface. The aft (tail) strut was unfaired.

Wind-off weight tares for the aforementioned configuration were recorded through the angle of attack test range of -6.0 to +14.0 degrees by one degree increments. The tunnel Q was set to approximately 40 psf, and uncorrected aerodynamic data were recorded as printout on an ASR-33 Teletype unit. It should be noted that each printed row of information included five channels of data at a particular angle of

attack condition, including a numerically averaged Q value obtained during that two-second sampling period. This feature of the data acquisition system eliminated the necessity for precise tunnel dynamic pressure management.

After several days had transpired, the above data collection procedure was duplicated in its entirety to verify the repeatability of the system. Additional data for test runs at Q values of 20 and 30 psf were also collected. Each pitch-pause polar run required about eight minutes for approximately 30 individual angle of attack settings.

D. ADAPTATION OF CALIBRATION WING

The calibration wing was originally designed for a three-strut support system. The wing attachment points had approximately two-inch square, contoured cover plates on both upper and lower surfaces (see figure 2). These were faired in with modeling clay and smoothed. The wing also had a one-half inch channel to accept the tail sting.

The forward section of the tail sting was duplicated to adapt the wing, but sufficient steel material was retained on the underside of the adaptor to allow the milling of a plate attachment slot. The centerplate was secured in this slot by two 1/4-20 cap screws. Two additional cap screws were inserted vertically through the adaptor and wing spar to fasten into tapped holes on the plate's upper surface. The wing adaptor was designed to position the wing quarter-chord

on the plate's vertical centerline, which aligned with the balance focal point at zero angle of attack. This feature was provided for geometrical simplifications in the moment transfer equations, as outlined in Appendix B.

A slender, bullet-shaped body fairing was incorporated to insure minimal flow disruption at the wing root. The fairing was constructed with two separate wooden center sections. One center section was solid (without wing cutouts) to provide a smooth fairing during wing-off weight and aerodynamic tare evaluations (see Figure 11). The other center section was contoured to accept the wing adaptor and wing panel (see Figure 12). Both fairings were fastened to either plate or wing adaptor by cap screws. Careful attention to tolerance details provided a close fit of the fairing to wing and plate and enhanced the torsional rigidity of the wing root, inasmuch as the actual wing spar details allowed only a one-half inch wide steel adaptor.

The fairing was kept as small as possible, and the two-inch fairing diameter represented 5.56 percent of the wing's three foot span. The small relative size of the body fairing provided an intuitive feeling that wing lift carry-over in the fairing area would be quite reasonable.

An approximate stress analysis was performed for wing root bending of the aluminum wing spar. A 40 percent margin over yield was estimated for design loads at $Q = 60$ psf. This seemed reasonable, since maximum test Q was selected as 40 psf.

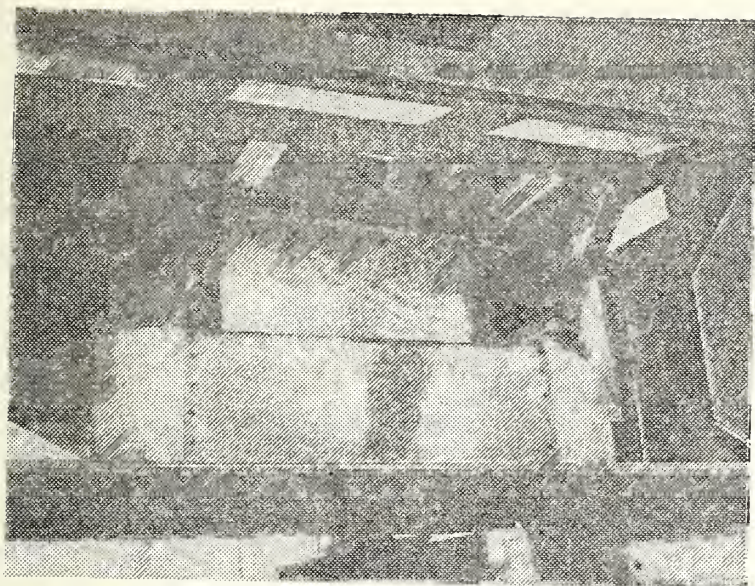


Figure 11. Centerplate
and bullet fairing,
wing-off.

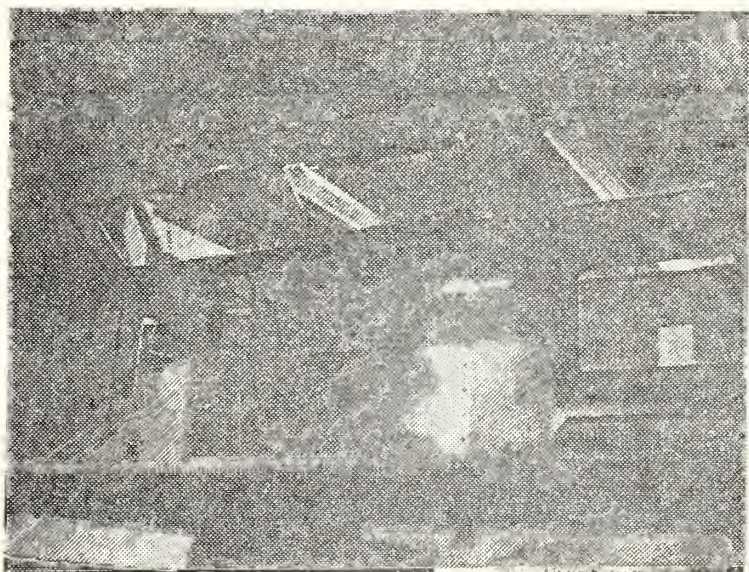


Figure 12. Centerplate
and bullet fairing,
wing-on.

E. CENTERPLATE MOUNTING SYSTEM EXPERIMENTS

The objective of the centerplate mount experiments was to document accurately the performance of the modified calibration wing when installed on the plate mount, including estimates of the aerodynamic tares for the wing-off configuration. With this information, a quantitative comparison between both support systems could be made with reasonable certainty.

After the centerplate (described in Section III C) was installed, the body fairing was fastened onto the upper edge of the plate and wind-off weight tares were taken (see Section IV C). Wind-on runs were then conducted for Q values of 40, 30 and 20 psf, respectively.

The body fairing was removed from the tunnel, the wing-on center section was fitted, and then the entire wing-body assembly was reinstalled onto the plate support in the tunnel test section. A complete repetition of the previous wing-off steps was then performed.

Incorporation of tares for both wing-off/on cases was accomplished by means of computer programs presented in a following section.

F. THEORETICALLY EXPECTED RESULTS

Independent of mounting considerations, one should have an engineering feel for the expected results of a finite wing with a symmetrical airfoil. Section data on NACA 63-010 and

NACA 63-009 airfoils (Ref. 6) were the basis for approximate estimates of the ideal, free-air behavior of the calibration wing. The lift curve, drag polar and pitching moment curve will be reviewed in that order.

The referenced section data indicated a linear section lift curve slope of approximately 0.10 deg^{-1} . Correction for a wing aspect ratio of six yielded a three-dimensional lift curve slope on the order of 0.073 deg^{-1} (Ref. 7). Of course, a finite wing's $C_{L_{\max}}$ will occur at an angle of attack several degrees higher than the 10 degree value observed in the sectional data. However, approximately the same maximum lift coefficient would be expected for both two- and three-dimensional wing cases when operated with approximately the same Reynolds number values. Further inspection of symmetrical airfoil behavior indicates a lift curve symmetric about the origin with a zero lift angle (α_{0L}) of zero.

The drag polar (plot of C_L vs. C_D) is also symmetric, but about the coefficient of drag axis with a zero lift drag (C_{D_0}) value of approximately 0.008 (80 drag counts). The C_{D_0} values of both the two- and three-dimensional wing cases should be identical, since induced drag is not a factor at zero lift for an untwisted and uncambered wing. Note that the C_{D_0} estimate of 0.008 was based for a model with standard roughness, and no drag-bucket phenomenon (characteristic of laminar flow airfoils) was expected.

As a check on the magnitude of the drag tares for the centerplate and fairing, an estimate of the turbulent skin friction drag at $Q = 40$ psf in sea-level conditions was performed.

Plate Reynolds number:

$$(R_N)_{\text{Plate}} = \frac{Vx}{\nu} = \frac{(183.5 \text{ ft/sec})(1.67 \text{ ft})}{0.000158 \text{ ft}^2/\text{sec}} \approx 1.94 \times 10^6$$

Body fairing Reynolds number:

$$(R_N)_{\text{Fairing}} \approx 1.94 \times 10^6 \times \frac{(2.67 \text{ ft})}{(1.67 \text{ ft})} \approx 3.10 \times 10^6$$

If the entire plate were in turbulent flow, then skin-friction drag would be:

$$D_{f_p} = 2 \times Q \times S \times C_f$$

where

$$C_f = 0.455 \times (\log_{10} R_N)^{-2.58}$$

$$\text{Hence } D_{f_p} = 2 \times (40 \text{ psf})(1.18 \text{ ft}^2)(0.00396) = 0.374 \text{ lb}$$

If the entire body fairing were in turbulent flow, then:

$$D_{f_F} = 1 \times (40 \text{ psf})(1.40 \text{ ft}^2)(0.00379) = 0.212 \text{ lb}$$

where S_f = cylindrical approximation to body fairing wetted areal Total drag then becomes:

$$D_T = D_{f_p} + D_{f_F} = 0.586 \text{ lb}$$

And the drag coefficient, referenced to wing area, would be:

$$C_{D_T} = \frac{D_T}{QS} = \frac{0.586 \text{ lb}}{(40 \text{ psf})(1.5 \text{ ft}^2)} = 0.0098$$

The turbulent flow approximation was assumed based upon the observation that the leading edge of the centerplate had a 0.030-inch bluntness for safety and ease of fabrication, while the plate surface was smooth but unpolished for the experiment.

Wing-alone stability as measured by the slope $dC_{M_{\bar{c}/4}}/dC_L$ provides a direct indication of the wing aerodynamic center location. The slope would be zero if the aerodynamic center were located at the wing quarter-MAC location. Additionally, the symmetry of the airfoil would lead one to expect a zero value of $C_{M_{\bar{c}/4}}$ at zero lift; i.e., $C_{M_0} = 0$.

V. PRESENTATION OF DATA

A summary of all the wind tunnel runs performed in conjunction with this study are listed in Table 1. Corrected aerodynamic data for the runs at $Q = 40, 30, \text{ and } 20 \text{ psf}$ are presented in that order. Each tabulated run in this section represents reduced data for 27 geometric angle of attack conditions. The geometric angle of attack was varied from minus six degrees to plus fourteen degrees in one degree increments. As a repeatability check within each run, the angle of attack was then returned to plus six degrees and reduced in two degree increments to minus four degrees. The data presented for each geometric angle of attack condition were the aerodynamic angle of attack, Q , C_L , C_D , and $C_{M\bar{c}/4}$. The three-strut configuration data are corrected only for weight tares. Centerplate configuration data are corrected for aerodynamic tares as well as weight tares, and tables of the reduced aerodynamic tare coefficients are presented immediately behind their respective run data.

Three-strut run 051501 and centerplate run 052703 at $Q = 40 \text{ psf}$ were selected as the most representative because of the higher nominal Q and subsequent removal of any possible taxing of balance resolution. Plots of C_L vs. α , C_D and $C_{M\bar{c}/4}$ were constructed for these data and immediately precede the table for their respective runs. The plots of run 051501

were reproduced on the plots for run 052703 to facilitate a direct comparison of calibration wing performance on each mounting system.

The reduction programs and storage records are presented in later sections of this report. The raw data are displayed in Appendix C.

Reference is not included on Reynolds number since the runs were made in virtually identical conditions and no scaling correlations were attempted.

Table I
Wind-Tunnel Run Log

DATE	RUN #	NOMINAL Q (psf)	PURPOSE
5-15-77	051577	0	Weight tare, calibration wing on three-strut mount
"	051501	40	Data for C_L vs., C_D , $C_{M\bar{c}}/4$
5-18-77	051877	0	Weight tare, calibration wing on three-strut mount
"	051801	40	Data for C_L vs., C_D , $C_{M\bar{c}}/4$
"	051802	30	" "
"	051803	20	" "
5-24-77	---	8-58	Q calibration, plate fairing in clear tunnel
5-26-77	052677	0	Weight tare, plate plus fairing, wing-off
"	052601	20	Aerodynamic tares for C_L , C_D , $C_{M\bar{c}}/4$
"	052602	40	" "
"	052603	30	" "
5-27-77	05277	0	Weight tare, plate plus fairing, wing-on
"	052701	20	Data for C_L vs., C_D , $C_{M\bar{c}}/4$
"	052702	30	" "
"	052703	40	" "

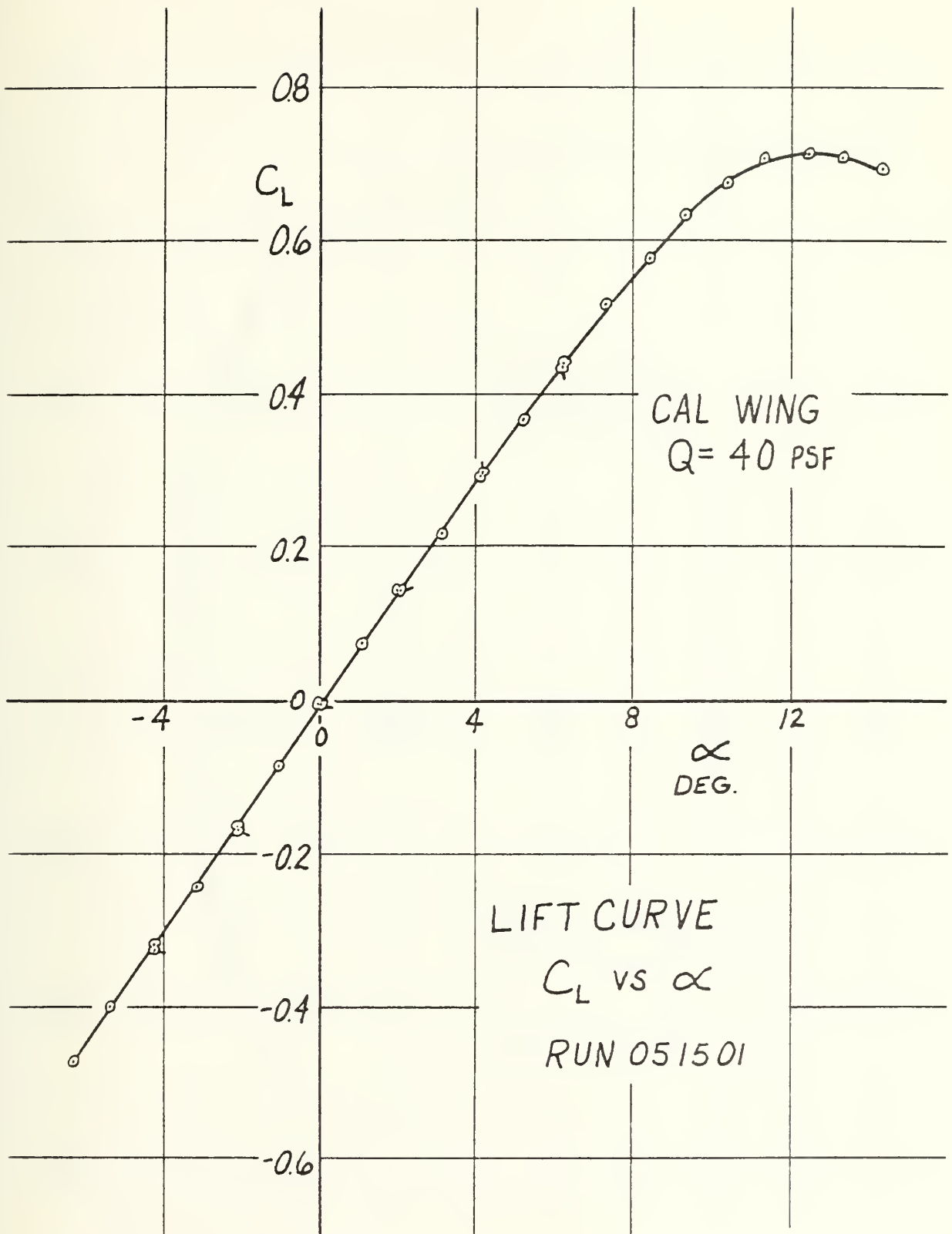


Figure 13. Lift curve, three-strut mount.

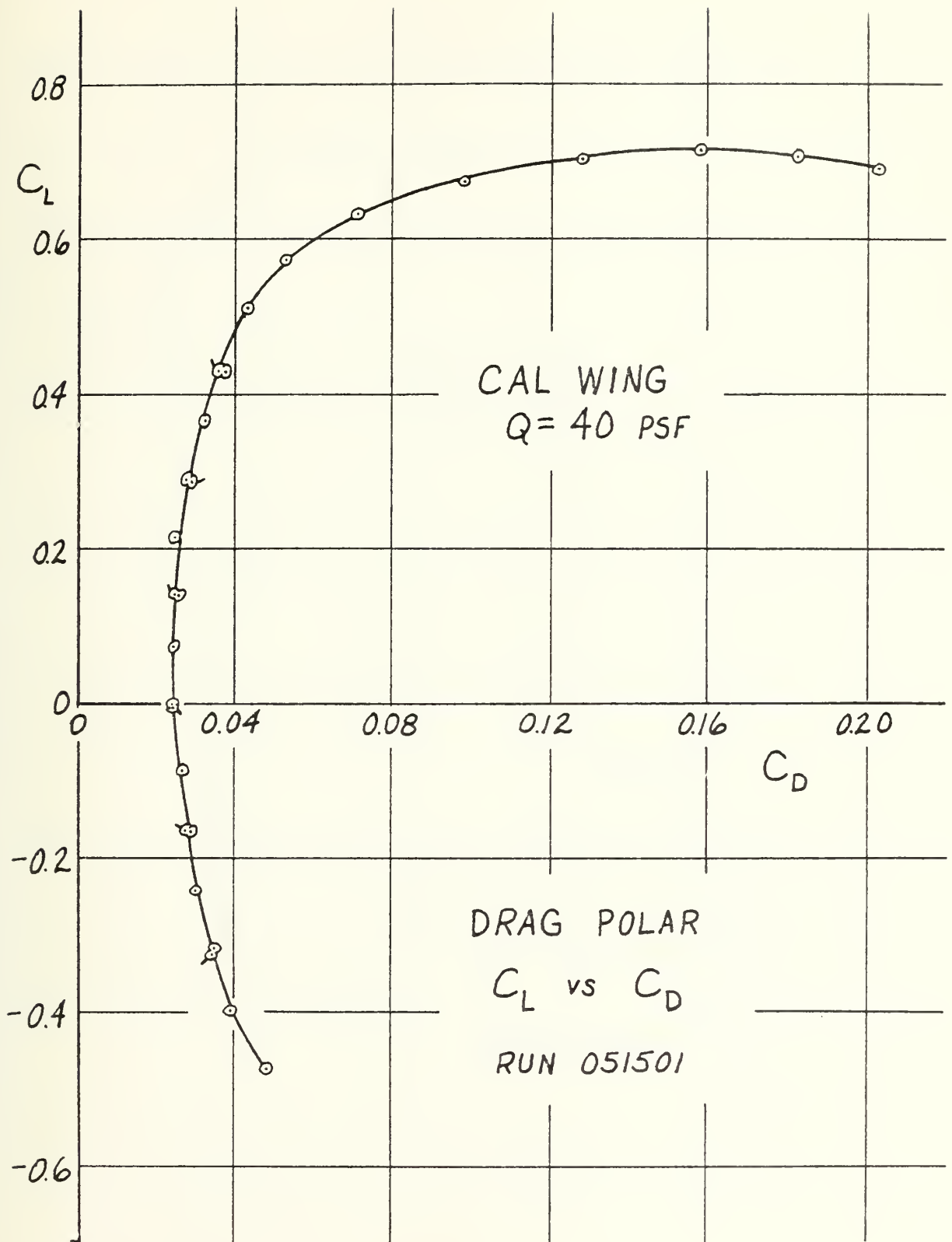


Figure 14. Drag polar, three-strut mount.

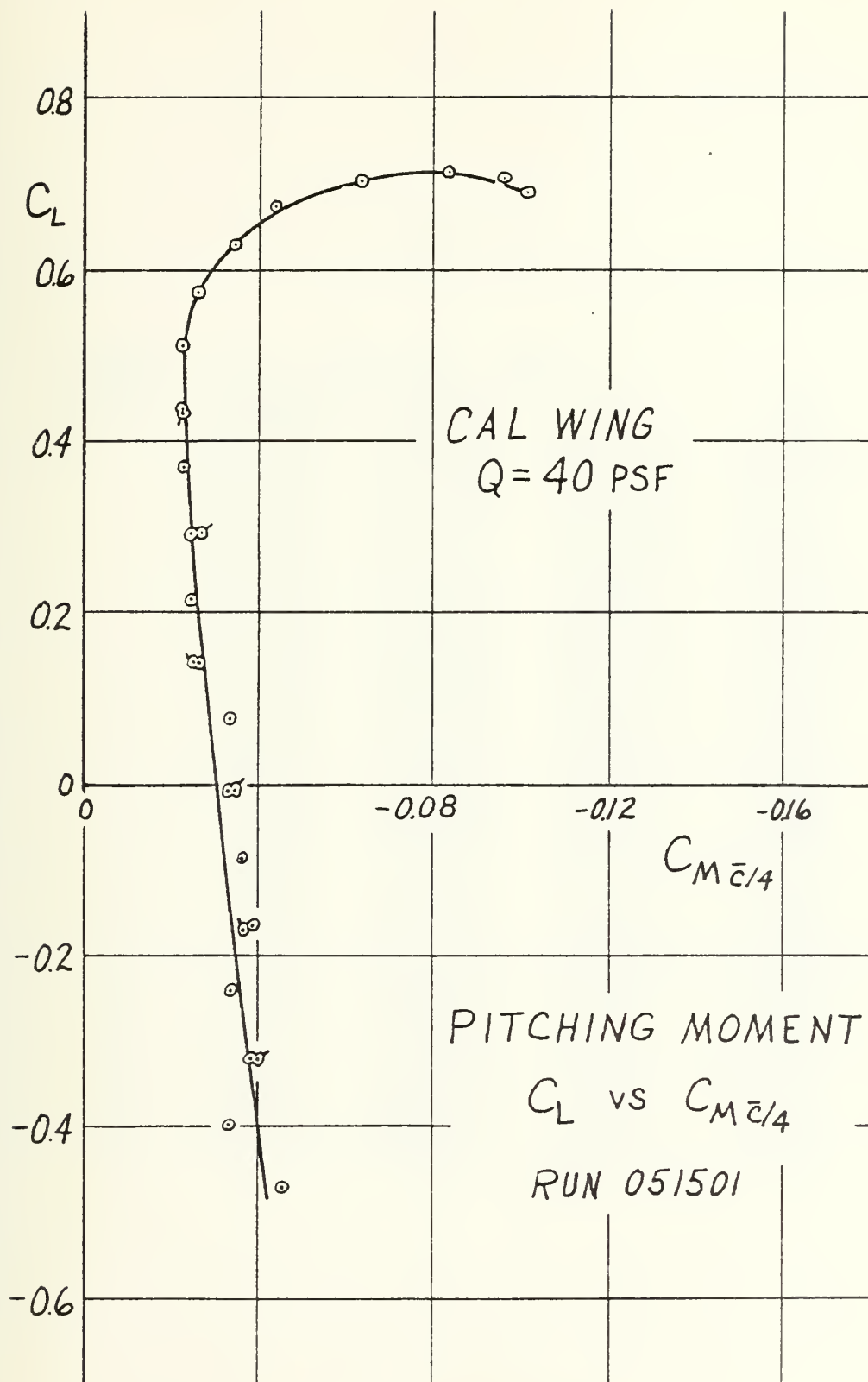


Figure 15. Pitching moment curve, three-strut mount.

TABLE II

CORRECTED DATA OF RUN # 51501

ROW #	AOA(DEG)	Q(PSF)	CL	CD	CM-C/4
1	-0.8917	41.2018	-0.4769	0.0468	-0.0395
2	-0.7407	41.4827	-0.3968	0.0389	-0.0336
3	-0.5911	41.2767	-0.3166	0.0348	-0.0374
4	-0.4446	40.8366	-0.2406	0.0299	-0.0328
5	-0.2967	41.8011	-0.1640	0.0281	-0.0375
6	-0.1485	42.2318	-0.0836	0.0263	-0.0352
7	-0.0031	41.8853	-0.0071	0.0248	-0.0320
8	0.1474	41.4827	0.0750	0.0250	-0.0324
9	0.2836	41.9228	0.1420	0.0247	-0.0265
10	0.4326	42.2599	0.2190	0.0262	-0.0254
11	0.5792	42.6157	0.2927	0.0288	-0.0236
12	0.7228	42.9434	0.3662	0.0322	-0.0223
13	0.8676	42.4471	0.4365	0.0372	-0.0215
14	1.0161	42.8030	0.5133	0.0427	-0.0214
15	1.1540	42.7280	0.5774	0.0532	-0.0249
16	1.2849	42.0913	0.6332	0.0714	-0.0342
17	1.4132	41.8011	0.6773	0.0970	-0.0428
18	1.5335	41.0520	0.7038	0.1275	-0.0631
19	1.6438	40.9490	0.7158	0.1576	-0.0835
20	1.7326	41.2299	0.7073	0.1816	-0.0973
21	1.8235	40.2093	0.6940	0.2032	-0.1119
22	0.8661	42.0258	0.4339	0.0367	-0.0212
23	0.5771	41.1456	0.2874	0.0293	-0.0268
24	0.2875	41.2486	0.1429	0.0243	-0.0258
25	-0.0029	40.7898	-0.0086	0.0249	-0.0335
26	-0.0003	39.3291	-0.1670	0.0273	-0.0350
27	-0.5917	39.9003	-0.3230	0.0344	-0.0390

TABLE III

CORRECTED DATA OF RUN # 51801

ROW #	AOA(DEG)	Q(PSF)	CL	CD	CM-C/4
1	-0.8874	41.0404	-0.4754	0.0453	-0.0328
2	-0.7446	40.0947	-0.4031	0.0392	-0.0324
3	-0.5949	40.9936	-0.3228	0.0331	-0.0297
4	-0.4456	39.6453	-0.2418	0.0288	-0.0270
5	-0.2976	39.6172	-0.1654	0.0271	-0.0312
6	-0.1532	41.1341	-0.0914	0.0247	-0.0272
7	-0.0034	41.1060	-0.0076	0.0244	-0.0290
8	0.1420	40.9936	0.0664	0.0245	-0.0281
9	0.2879	41.9299	0.1438	0.0249	-0.0262
10	0.4352	41.5273	0.2215	0.0259	-0.0218
11	0.5798	41.8738	0.2935	0.0288	-0.0232
12	0.7212	41.6678	0.3635	0.0330	-0.0251
13	0.8696	41.7801	0.4394	0.0374	-0.0232
14	1.0127	41.6310	0.5119	0.0429	-0.0209
15	1.1516	42.0236	0.5750	0.0531	-0.0222
16	1.2873	41.5929	0.6334	0.0725	-0.0356
17	1.4129	41.7240	0.6767	0.0983	-0.0449
18	1.5317	41.4711	0.7042	0.1612	-0.2365
19	1.6410	41.6490	0.7210	0.1569	-0.0938
20	1.7367	40.6752	0.7157	0.1817	-0.0975
21	1.8167	40.5442	0.6829	0.2011	-0.1102
22	0.8644	41.3213	0.4360	0.0374	-0.0224
23	0.5786	42.0142	0.2916	0.0290	-0.0235
24	0.2849	41.2183	0.1388	0.0250	-0.0259
25	-0.0002	40.9842	-0.0023	0.0245	-0.0282
26	-0.2983	39.7576	-0.1665	0.0270	-0.0318
27	-0.5982	40.6565	-0.3282	0.0344	-0.0350

TABLE IV

CORRECTED DATA OF RUN # 51802

ROW #	AOA(DEG)	Q(PSF)	CL	CD	CM-C/4
1	-0.8828	30.2724	-0.4721	0.0445	-0.0335
2	-0.7484	29.9447	-0.4000	0.0374	-0.0276
3	-0.5964	29.7294	-0.3255	0.0324	-0.0296
4	-0.4449	30.2350	-0.2388	0.0275	-0.0246
5	-0.2933	29.6732	-0.1582	0.0256	-0.0282
6	-0.1503	30.0103	-0.0864	0.0230	-0.0225
7	-0.0048	30.3848	-0.0098	0.0221	-0.0214
8	0.1440	29.7106	0.0696	0.0224	-0.0222
9	0.2906	30.7032	0.1481	0.0234	-0.0237
10	0.4333	30.6751	0.2199	0.0249	-0.0197
11	0.5767	30.7125	0.2887	0.0275	-0.0179
12	0.7291	30.7500	0.3742	0.0317	-0.0191
13	0.8676	31.0028	0.4411	0.0358	-0.0178
14	1.0154	30.7032	0.5161	0.0433	-0.0221
15	1.1509	30.4035	0.5761	0.0541	-0.0226
16	1.2892	30.8998	0.6316	0.0712	-0.0204
17	1.4138	30.7593	0.6732	0.0994	-0.0453
18	1.5309	30.2537	0.7078	0.1743	-0.3904
19	1.6379	30.0758	0.7160	0.1578	-0.0858
20	1.7313	30.2537	0.7101	0.1818	-0.0980
21	1.8228	30.4016	0.6929	0.2042	-0.1151
22	0.8648	30.9372	0.4368	0.0370	-0.0240
23	0.5796	30.5533	0.2932	0.0284	-0.0231
24	0.2834	31.0028	0.1364	0.0247	-0.0289
25	-0.0047	30.8998	-0.0096	0.0236	-0.0284
26	-0.2946	30.7593	-0.1606	0.0264	-0.0334
27	-0.5978	30.4410	-0.3276	0.0326	-0.0288

TABLE V

CORRECTED DATA OF RUN # 51803

ROW #	AOA(DEG)	Q(PSF)	CL	CD	CM-C/4
1	-0.9016	20.1786	-0.4986	0.0424	-0.0343
2	-0.7527	20.4595	-0.4203	0.0361	-0.0307
3	-0.6109	20.7966	-0.3491	0.0317	-0.0317
4	-0.4609	20.3752	-0.2651	0.0251	-0.0187
5	-0.3103	20.2442	-0.1863	0.0243	-0.0293
6	-0.1575	20.6374	-0.0983	0.0217	-0.0221
7	-0.0115	20.7123	-0.0209	0.0227	-0.0290
8	0.1308	20.7966	0.0529	0.0219	-0.0239
9	0.2847	20.8809	0.1392	0.0225	-0.0217
10	0.4299	20.6749	0.2144	0.0235	-0.0146
11	0.5719	20.8060	0.2830	0.0260	-0.0117
12	0.7269	21.0007	0.3728	0.0308	-0.0172
13	0.8723	20.6749	0.4440	0.0340	-0.0080
14	1.0158	21.1056	0.5170	0.0414	-0.0107
15	1.1590	20.6468	0.5853	0.0536	-0.0117
16	1.2797	20.9277	0.6215	0.0678	-0.0076
17	1.4087	21.0213	0.6697	0.0971	-0.0205
18	1.5226	20.3846	0.6926	0.1946	-0.3953
19	1.6317	20.5251	0.7058	0.1567	-0.0830
20	1.7286	20.5157	0.7008	0.1828	-0.1032
21	1.8135	20.5906	0.6777	0.2031	-0.1187
22	0.8724	20.8809	0.4439	0.0355	-0.0100
23	0.5815	20.6936	0.2966	0.0260	-0.0148
24	0.2778	20.7779	0.1273	0.0226	-0.0202
25	-0.0131	20.5906	-0.0235	0.0219	-0.0246
26	-0.3105	20.7779	-0.1868	0.0250	-0.0319
27	-0.6123	20.3565	-0.3516	0.0313	-0.0265

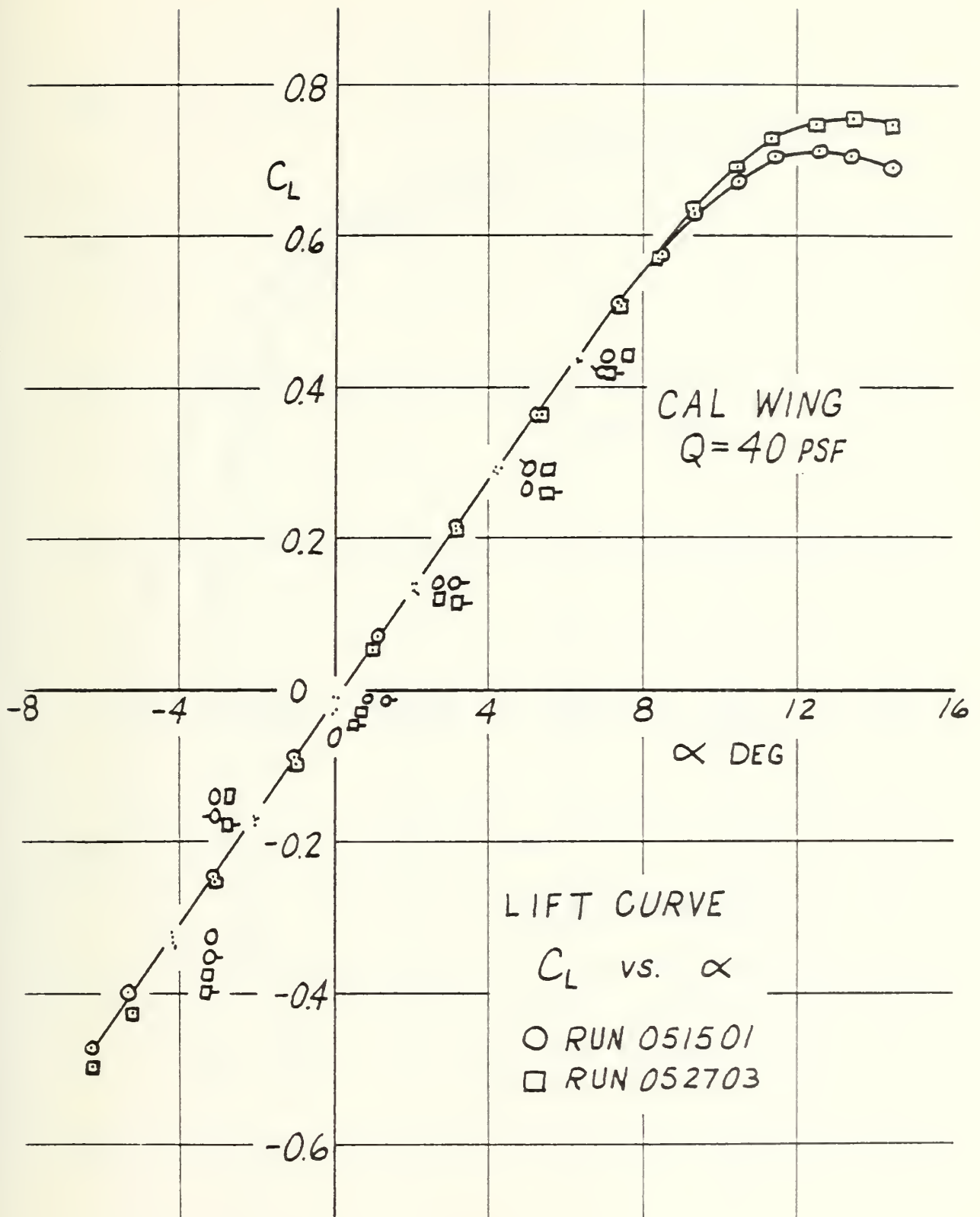


Figure 16. Lift curve, centerplate mount.

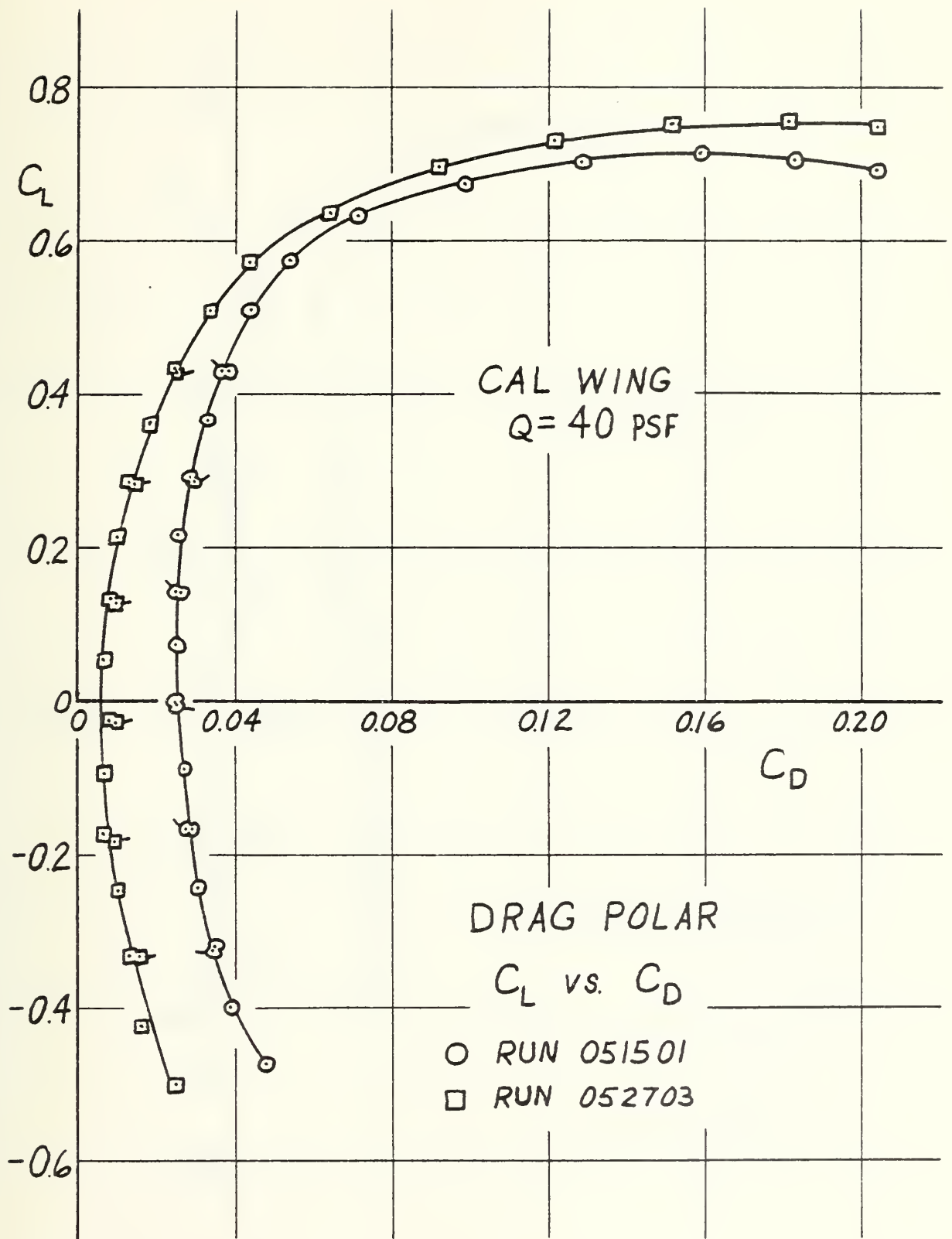


Figure 17. Drag polar, centerplate mount.

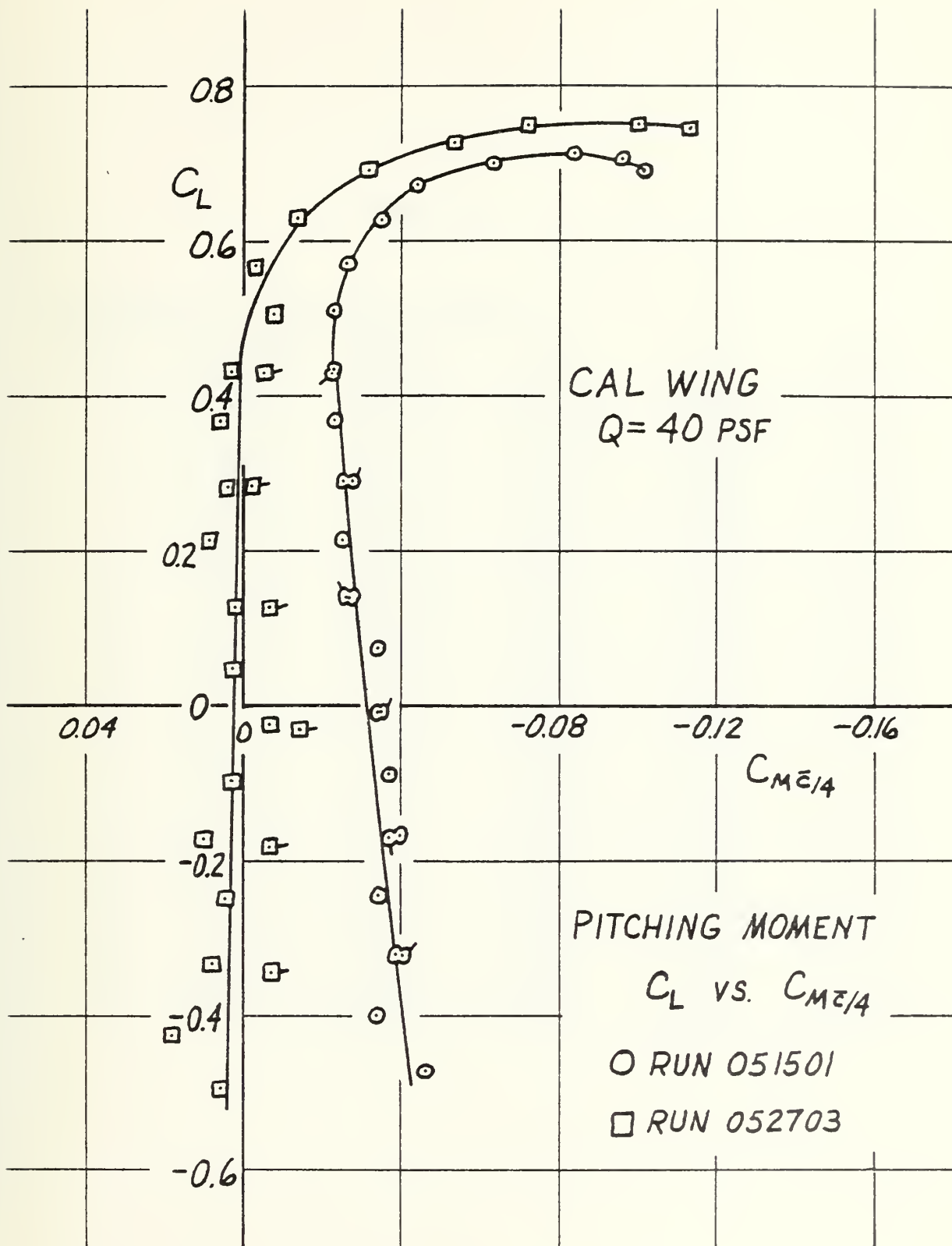


Figure 18. Pitching moment curve, centerplate mount.

TABLE VI

CORRECTED DATA OF RUN # 52703

ROW #	AOA(DEG)	Q(PSF)	CL	CD	CM-C/4
1	-6.2505	39.4395	-0.4958	0.0248	0.0074
2	-5.2190	39.7807	-0.4212	0.0169	0.0191
3	-4.1657	39.4495	-0.3338	0.0130	0.0084
4	-3.1060	40.1219	-0.2458	0.0099	0.0049
5	-2.0654	40.0216	-0.1728	0.0065	0.0100
6	-1.0133	39.0610	-0.0983	0.0069	0.0028
7	-0.0023	40.5836	-0.0237	0.0083	-0.0072
8	1.0470	40.6839	0.0525	0.0070	0.0029
9	2.0834	40.7542	0.1334	0.0083	0.0022
10	3.1529	40.7140	0.2145	0.0097	0.0089
11	4.1833	40.5735	0.2840	0.0133	0.0046
12	5.2486	40.8545	0.3647	0.0178	0.0073
13	6.2822	41.1657	0.4362	0.0238	0.0043
14	7.3203	40.7442	0.5085	0.0332	-0.0076
15	8.3716	40.8746	0.5729	0.0438	-0.0009
16	9.4025	41.3664	0.6384	0.0637	-0.0107
17	10.4536	40.7542	0.6943	0.0922	-0.0291
18	11.4654	40.7743	0.7299	0.1215	-0.0525
19	12.4795	40.4832	0.7530	0.1509	-0.0712
20	13.4730	39.8911	0.7588	0.1815	-0.1003
21	14.4694	40.1219	0.7528	0.2043	-0.1143
22	6.2910	41.0452	0.4310	0.0250	-0.0040
23	4.1850	40.4531	0.2851	0.0144	-0.0018
24	2.0951	40.9047	0.1280	0.0095	-0.0071
25	-0.0051	41.1657	-0.0283	0.0094	-0.0149
26	-2.0721	39.9915	-0.1821	0.0095	-0.0083
27	-4.1862	40.4832	-0.3412	0.0157	-0.0066

TABLE VII

AERODYNAMIC TARES OF RUN # 52703

ROW #	AOA(DEG)	Q(PSF)	DCL	DCD	SCM-C/4
1	-6.2505	39.4395	-0.0101	-0.0092	0.0203
2	-5.2190	39.7807	-0.0121	-0.0106	0.0281
3	-4.1657	39.4495	-0.0085	-0.0111	0.0280
4	-3.1060	40.1219	-0.0117	-0.0109	0.0250
5	-2.0654	40.0216	-0.0134	-0.0102	0.0197
6	-1.0133	39.8610	-0.0145	-0.0102	0.0170
7	-0.0023	40.5836	-0.0172	-0.0094	0.0100
8	1.0470	40.6839	-0.0157	-0.0100	0.0074
9	2.0834	40.7542	-0.0178	-0.0098	0.0049
10	3.1529	40.7140	-0.0152	-0.0103	0.0073
11	4.1833	40.5735	-0.0172	-0.0106	0.0062
12	5.2486	40.8545	-0.0162	-0.0104	0.0068
13	6.2822	41.1657	-0.0188	-0.0106	0.0061
14	7.3203	40.7442	-0.0213	-0.0103	0.0013
15	8.3716	40.8746	-0.0214	-0.0103	0.0013
16	9.4025	41.3664	-0.0230	-0.0112	0.0048
17	10.4536	40.7542	-0.0214	-0.0111	0.0031
18	11.4654	40.7743	-0.0237	-0.0112	0.0020
19	12.4795	40.4832	-0.0243	-0.0118	0.0041
20	13.4730	39.8911	-0.0246	-0.0115	0.0012
21	14.4694	40.1219	-0.0248	-0.0119	0.0005
22	6.2810	41.0452	-0.0207	-0.0099	-0.0004
23	4.1850	40.4531	-0.0187	-0.0100	0.0026
24	2.0951	40.9047	-0.0174	-0.0090	-0.0031
25	-0.0051	41.1657	-0.0170	-0.0092	0.0082
26	-2.0721	39.9915	-0.0171	-0.0087	0.0099
27	-4.1862	40.4832	-0.0158	-0.0084	0.0095

TABLE VIII

CORRECTED DATA OF RUN # 52702

ROW #	AOA(DEG)	Q(PSF)	CL	CD	CM-C/4
1	-6.2427	30.1529	-0.4029	0.0238	0.0093
2	-5.2126	30.8980	-0.4108	0.0173	0.0187
3	-4.1453	30.3039	-0.3283	0.0108	0.0256
4	-3.1054	30.6865	-0.2464	0.0085	0.0096
5	-2.0594	30.3945	-0.1629	0.0066	0.0110
6	-1.0084	30.5355	-0.0894	0.0055	0.0101
7	0.0065	30.7369	-0.0093	0.0073	0.0015
8	1.0417	30.5959	0.0688	0.0083	-0.0038
9	2.0987	30.6060	0.1535	0.0080	0.0064
10	3.1618	30.7570	0.2275	0.0078	0.0267
11	4.1932	30.7671	0.3019	0.0112	0.0213
12	5.2570	30.8778	0.3769	0.0158	0.0257
13	6.2951	30.9785	0.4558	0.0226	0.0176
14	7.3239	30.7872	0.5177	0.0320	0.0013
15	8.3844	30.7570	0.5939	0.0452	0.0098
16	9.4051	30.6261	0.6443	0.0631	0.0027
17	10.4486	30.5858	0.7023	0.0922	-0.0179
18	11.4685	30.5556	0.7351	0.1215	-0.0430
19	12.4819	30.5758	0.7570	0.1514	-0.0634
20	13.4732	30.1227	0.7591	0.1798	-0.0897
21	14.4732	30.4549	0.7592	0.2059	-0.1175
22	6.2910	30.5456	0.4491	0.0245	-0.0015
23	4.1905	30.9061	0.2959	0.0132	0.0022
24	2.0844	30.4046	0.1301	0.0100	-0.0094
25	0.0020	30.7570	-0.0167	0.0101	-0.0100
26	-2.0680	30.7369	-0.1750	0.0092	-0.0076
27	-4.1848	30.3643	-0.3372	0.0136	0.0038

TABLE IX

AERODYNAMIC TARES OF RUN # 52702

ROW #	AOA(DEG)	Q(PSF)	DCL	DCD	DCM-C/4
1	-6.2427	30.1529	-0.0067	-0.0094	0.0188
2	-5.2126	30.8980	-0.0097	-0.0104	0.0240
3	-4.1453	30.3039	-0.0078	-0.0119	0.0331
4	-3.1054	30.6865	-0.0087	-0.0115	0.0287
5	-2.0594	30.3945	-0.0127	-0.0101	0.0197
6	-1.0084	30.5355	-0.0101	-0.0116	0.0250
7	0.0065	30.7369	-0.0110	-0.0104	0.0179
8	1.0417	30.5959	-0.0094	-0.0098	0.0054
9	2.0987	30.6060	-0.0098	-0.0109	0.0093
10	3.1618	30.7570	-0.0124	-0.0109	0.0104
11	4.1932	30.7671	-0.0145	-0.0114	0.0093
12	5.2570	30.8778	-0.0121	-0.0119	0.0145
13	6.2951	30.9785	-0.0143	-0.0116	0.0119
14	7.3239	30.7872	-0.0149	-0.0114	0.0068
15	8.3844	30.7570	-0.0182	-0.0120	0.0083
16	9.4051	30.6261	-0.0199	-0.0130	0.0115
17	10.4486	30.5858	-0.0190	-0.0124	0.0077
18	11.4685	30.5556	-0.0210	-0.0124	0.0054
19	12.4819	30.5758	-0.0219	-0.0129	0.0062
20	13.4732	30.1227	-0.0223	-0.0121	0.0010
21	14.4732	30.4549	-0.0251	-0.0120	-0.0045
22	6.2910	30.5456	-0.0187	-0.0107	0.0000
23	4.1905	30.9081	-0.0154	-0.0102	-0.0006
24	2.0844	30.4046	-0.0156	-0.0089	-0.0078
25	0.0020	30.7570	-0.0175	-0.0093	0.0080
26	-2.0688	30.7369	-0.0151	-0.0089	0.0085
27	-4.1848	30.3643	-0.0138	-0.0088	0.0106

TABLE X

CORRECTED DATA OF RUN # 52701

ROW #	ROA(DEG)	Q(PSF)	CL	CD	CM-C/4
1	-6.2698	20.2376	-0.5061	0.0256	0.0066
2	-5.2260	20.0659	-0.4310	0.0199	0.0054
3	-4.1855	19.9346	-0.3581	0.0141	0.0030
4	-3.1238	19.6519	-0.2751	0.0103	0.0095
5	-2.0751	20.0659	-0.1870	0.0057	0.0160
6	-1.0229	19.9346	-0.1132	0.0067	0.0068
7	-0.0059	20.1265	-0.0297	0.0085	-0.0038
8	1.0464	19.9043	0.0515	0.0068	0.0157
9	2.0796	20.1568	0.1272	0.0041	0.0337
10	3.1475	20.0962	0.2073	0.0058	0.0422
11	4.1750	20.1770	0.2721	0.0086	0.0403
12	5.2513	20.0457	0.3709	0.0144	0.0376
13	6.2841	20.2275	0.4378	0.0204	0.0355
14	7.3462	19.9952	0.5149	0.0319	0.0106
15	8.3705	20.1770	0.5727	0.0428	0.0195
16	9.4025	20.0760	0.6400	0.0654	0.0033
17	10.4337	19.7428	0.6944	0.0951	-0.0168
18	11.4662	19.9447	0.7312	0.1232	-0.0373
19	12.4792	19.7629	0.7526	0.1531	-0.0572
20	13.4718	19.8538	0.7568	0.1829	-0.0900
21	14.4691	19.6519	0.7524	0.2050	-0.1016
22	6.2839	20.0558	0.4373	0.0228	0.0095
23	4.1783	20.3386	0.2758	0.0113	0.0194
24	2.0749	19.8437	0.1195	0.0073	0.0084
25	-0.0034	20.3284	-0.0256	0.0118	-0.0257
26	-2.0942	20.1265	-0.2183	0.0094	-0.0056
27	-4.2092	19.9548	-0.3773	0.0161	-0.0058

TABLE XI

AERODYNAMIC TARES OF RUN # 52701

ROW #	AOA(DEG)	Q(PSF)	DCL	DCD	DCM-C/4
1	-6.2698	20.2376	-0.0084	-0.0085	0.0173
2	-5.2260	20.0659	-0.0106	-0.0076	0.0073
3	-4.1855	19.9346	-0.0096	-0.0088	0.0093
4	-3.1238	19.6519	-0.0138	-0.0096	0.0183
5	-2.0751	20.0659	-0.0148	-0.0104	0.0285
6	-1.0229	19.9346	-0.0125	-0.0114	0.0292
7	-0.0059	20.1265	-0.0166	-0.0101	0.0200
8	1.0464	19.9043	-0.0129	-0.0105	0.0134
9	2.0796	20.1568	-0.0169	-0.0134	0.0243
10	3.1475	20.0962	-0.0147	-0.0138	0.0297
11	4.1750	20.1770	-0.0142	-0.0145	0.0295
12	5.2513	20.0457	-0.0112	-0.0135	0.0266
13	6.2841	20.2275	-0.0170	-0.0136	0.0267
14	7.3462	19.9952	-0.0170	-0.0117	0.0107
15	8.3705	20.1770	-0.0175	-0.0124	0.0146
16	9.4025	20.0760	-0.0210	-0.0140	0.0215
17	10.4337	19.7428	-0.0183	-0.0121	0.0104
18	11.4662	19.9447	-0.0199	-0.0133	0.0148
19	12.4792	19.7629	-0.0190	-0.0136	0.0163
20	13.4718	19.8538	-0.0200	-0.0134	0.0120
21	14.4691	19.6519	-0.0194	-0.0131	0.0077
22	6.2839	20.0558	-0.0233	-0.0110	0.0053
23	4.1783	20.3385	-0.0198	-0.0127	0.0175
24	2.0749	19.8437	-0.0210	-0.0103	0.0030
25	-0.0034	20.3284	-0.0218	-0.0089	0.0104
26	-2.0942	20.1265	-0.0224	-0.0080	0.0126
27	-4.2092	19.9548	-0.0217	-0.0051	-0.0151

VI. CONCLUSIONS

A. DATA ANALYSIS

Comparison of the three-strut mount and centerplate mount results was best achieved by inspection of the last three plots in the previous section. The lift curve, drag polar and pitching moment curve will again be examined in order.

The lift curve data for both runs yields essentially the same lift curve slope. The slope value of 0.072 deg^{-1} compares favorably with the theoretical value of approximately 0.073 deg^{-1} . The centerplate mount yielded a $C_{L\text{max}}$ of 0.7588 vîce 0.7210 for the three-strut mount. Direct comparison of the measured $C_{L\text{max}}$ was not possible because the test Reynolds numbers were less than those on available published data. It is, however, roughly estimated that the $C_{L\text{max}}$ attainable would be on the order of 0.8 and so close agreement is indicated. Possible cause for the centerplate to exhibit a higher $C_{L\text{max}}$ may be attributed to aerodynamically smoothing the wing attach points with modelling clay/tape and removal of the three-strut interference source. Curve fitting the data points for the centerplate case indicates that its curve may fall very slightly below the three-strut curve. This would yield a very small negative C_L intercept for $\alpha = 0$. If the actual trace were lower, a possible cause might be a difference in bullet-fairing attitude with the wing-on adapter.

Inspection of the drag polar illustrated the need for accurate aerodynamic tares. The C_{Dmin} at $C_L = 0$ for the three-strut mount is 0.0250 compared to 0.0083 for the aerodynamically corrected centerplate coefficient. This is a gross discrepancy, and one which prompted the construction of a mount for which aerodynamic tares could be more easily acquired. Inspection for the drag tare at the corresponding angle of attack for this condition yielded a drag tare coefficient of 0.0094. This compares very favorably with the estimate of 0.0098 calculated in section IV, part F. Comparison of the centerplate C_D value appears favorable with respect to section data corrected for aspect ratio, but again a direct comparison is not obtainable because of R_N mismatch.

The effect of the unfaired aft strut "disappearing" into the floor was exhibited at higher angles of attack. For each increasingly higher angle of attack condition, the values of the respective C_D 's approached each other. The uncompensated contribution of the faired struts became small by comparison to the large C_D measured, and the wetted area of the aft strut was reduced. When C_L is plotted vs. C_D , this effect showed up as a tendency toward vertical stacking of the data points from both cases at the higher C_L 's.

Finally, inspection of the pitching moment curve reveals several notable discrepancies for the three-strut case, run 051501. The pronounced slope of the linear range indicates that the quarter chord point is aft of the actual aerodynamic

center location. Cause for this would be the detail accuracy required for a chord of 0.5 feet. An error of only a few hundredths of an inch readily shows up. The displacement of the curve to the right indicates the uncorrected interference effects of the three-strut mount, and possibly to a lesser extent, unavoidable limits on airfoil uniformity at this small scale. The airfoil is nominally accurate in contour to 0.001 inches to the quarter chord point and to 0.003 inches thereafter. The centerplate plot of run 052703 showed that marked improvement was available with aerodynamic tares. The relatively large scatter exhibited by the data points was attributed to the small scale and working close to the limits of the balance resolution.

Possible biasing was also noted for the centerplate pitching moment case, in that the repeatability check points predominantly fall to the right for each Q tested. Attempts at localizing this within the data were not conclusive, and the need for additional data points would be indicated for work in which a precise pitching moment was required. Resolution of $C_{M\bar{c}}/4$ inferred by the 27 data points of the presented runs is on the order of 0.005. The pitching moment curve for the centerplate mount does, however, show a considerable improvement over the three-strut mount in that it falls much closer to zero for its constant range. Also, the slope of the faired curve appeared more nearly vertical, indicating a better coincidence of the quarter-chord point with the wing

aerodynamic center. The scatter of the data points somewhat tempered this last observation. A possible fix for the scatter may involve a change of the drag-moment strain gauges on the modified balance to improve the conditioning of the reduction matrix as mentioned by Concannon in Ref. 1, pg. 59.

Summarizing, the centerplate mount has demonstrated a large improvement by incorporating readily attainable aerodynamic tares. The proof of concept experiment displayed excellent agreement with theoretical lift curve slope and indicated "predictable" tendencies for the drag polar and pitching moment curves. Mount flexibility was exhibited by readily adapting an existing calibration wing. The accuracy improvement available with centerplate mounting, coupled with an excellent data system and wall correction program, represents a powerful tool for academic endeavors and independent research on airframe configurations.

B. RECOMMENDATIONS

The single most disturbing hardware problem involved in the study was the scatter of the data points for the pitching moment coefficient. While this parameter is among the hardest to accurately measure in a small wind tunnel, it is felt that the additional effort to change strain gauges may be warranted if tunnel utilization improves. The current resolution would suffice for any academic use, but the uncertainty may be too great for some engineering work requiring a very precise pitching moment coefficient.

The longest current delay in data reduction is the task of manually reentering all the raw data into the department's HP9830 computer for reduction. The microprocessor data acquisition system does have the capability for instant data reduction but at the loss of the raw data. It also has a punched paper tape output capability. It is felt that the raw data should be retained for system analysis and trouble shooting, but that some additional effort be invested toward interfacing the punched paper tape as a direct input to a software reduction program in one of the available, digital computers.

Further work remains to obtain more complete and current tunnel calibrations including pressure distributions and flow inclinations. It is also recommended that future studies in the tunnel include methods of Reynolds number compensation such as boundary layer tripping, since restricted Reynolds number capability is an inherent tunnel limitation.

Finally, it is felt that this study has contributed to the practicality of the tunnel and that the Department of Aeronautics will see greater utilization of this facility. It is hoped that the advances in modern tunnel research and improved capabilities of this tunnel recommend themselves for a larger share of the Department's curricula and research.

APPENDIX A

BASIC AERODYNAMIC AND TUNNEL RELATIONS

A raw data row consists of geometric angle of attack, dynamic pressure, and three strain gauge outputs that have been numerically averaged during a two second sampling interval. The first strain gauge output is directly proportional to lift. Configuration of the balance mixes the drag and moment, consequently, the remaining two strain gauges outputs must be resolved by a calibration matrix. The elements were determined by static loadings and correlation. The calibration matrix to convert gauges outputs in volts D.C. to lift drag and moment force in lbs. was:

$$\begin{Bmatrix} L \\ D \\ M \end{Bmatrix} = \begin{bmatrix} -96.154 & 0 & 0 \\ 0 & 17.500 & 25.575 \\ 0 & -89.065 & -66.070 \end{bmatrix} \begin{Bmatrix} L_1 \\ L_2 \\ L_3 \end{Bmatrix}$$

The coefficients generated by the reduction programs are the non-dimensional coefficients C_L , C_D , and $C_{M\bar{c}/4}$ given by the relations:

$$C_L = L/QS$$

$$C_D = D/QS$$

$$C_{M\bar{c}/4} = M\bar{c}/4/QS\bar{c}$$

$$\begin{matrix} h_1 & - & .0104 & 0 & 0 \\ h_2 & & 0 & -.0584 & -.1024 \\ h_3 & & 0 & .0194 & .0170 \end{matrix}$$

C_L was assumed as the independent variable and was only corrected for aerodynamic tares. Geometric angle of attack, and drag were corrected for wall corrections and aerodynamic tares. All data was corrected for wind-off dead weight zero readings and therefore, only the differential readings due to aerodynamic loading were reduced.

Wall corrections take the following form of those on pg. 341, 343 of Ref. 4:

$$\alpha_{aero} = \alpha_{geom} + \Delta\alpha$$

$$\text{Where } \Delta\alpha = \frac{S}{C} 57.3 C_L = 0.6102 C_L \text{ deg.}$$

$$C_D = C_{Du} + \Delta C_D$$

$$\text{Where } \Delta C_D = \delta \frac{S}{C} C_L^2 = 0.0106 C_L^2$$

$$S = \text{Wing area, } 1.5 \text{ ft}^2$$

$$C = \text{Tunnel cross-sectional area, } 14.5 \text{ ft}^2$$

$$\delta = \text{Tunnel factor given by Pope on pg. 343 of Ref. 2,} \\ = 0.103 \text{ for the } 3.5 \times 5.0 \text{ octagonal configuration}$$

ΔC_M was not utilized since the test was wing alone.

No tares other than dead weight were available for the three-strut mount. Wing-off runs were obtained to provide aerodynamic tares for the centerplate mount support situation.

APPENDIX B

MOUNT TRANSFER EQUATIONS

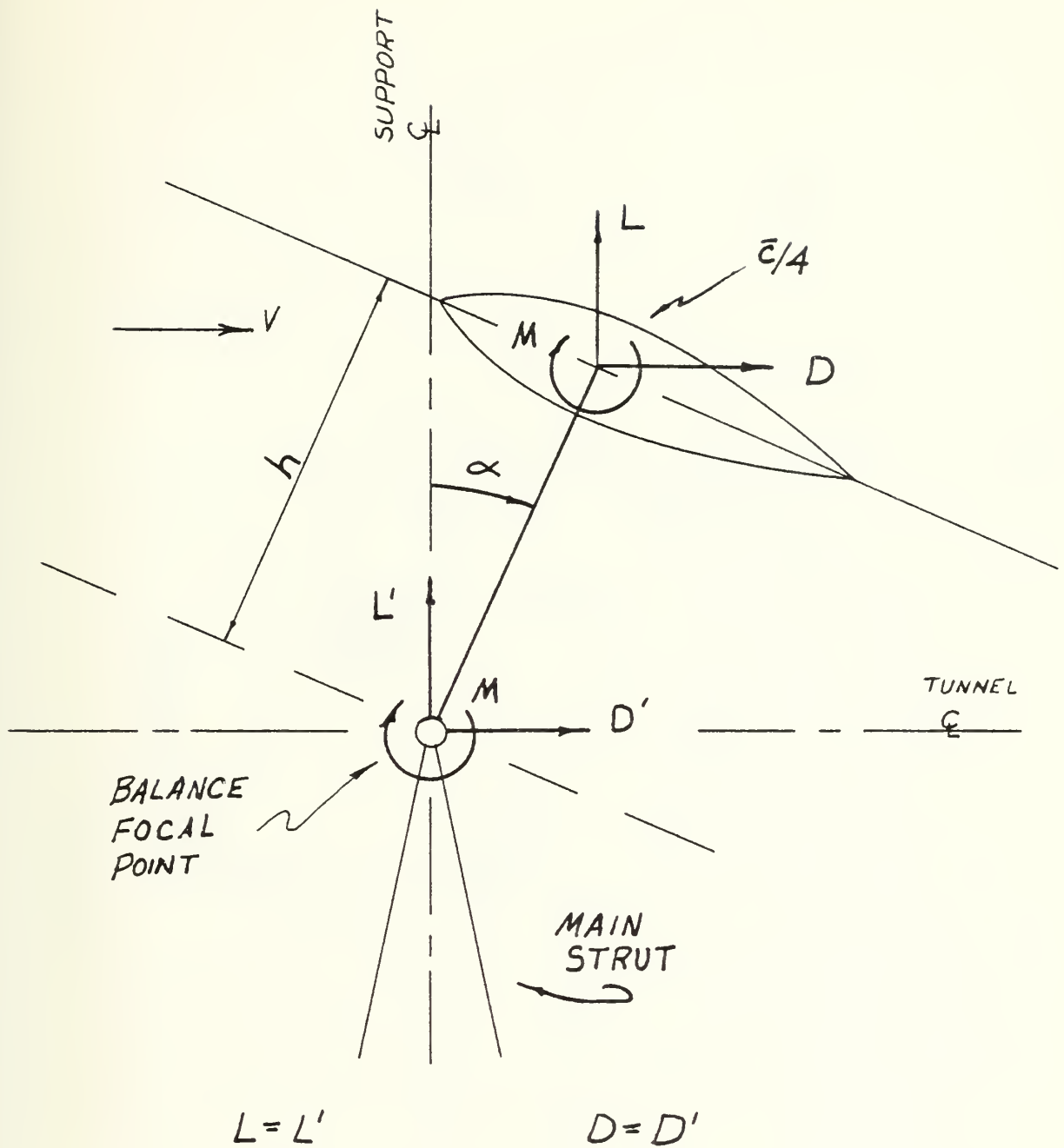
The focal line about which the three component balance resolves lift, drag and moment is centered 25.500 inches above the main beam and on the centerline of the tunnel test section. The three-strut mount wing trunnions are coincident with this axis and as long as the wing A.C. was also coincident no further corrections would be necessary. Plans of the calibration wing indicate that the A.C. was one-tenth inch above the focal axis at zero model angle when on the three-strut mount. The simple moment transfer resulted and the relation can be seen in figure 19.

$$C_M = C_M' - \frac{h}{\bar{c}} \cos \alpha C_D + \frac{h}{\bar{c}} \sin \alpha C_L$$

The main trunnion of the centerplate mount is necessarily below this focal axis and so the aerodynamic forces must be transferred from the model to the focal axis. This relation is slightly different since the pivot axis is not coincident with the focal axis. Also, the wing is located above the upper surface of the centerplate. The equation follows and the relation may be seen on figure 20.

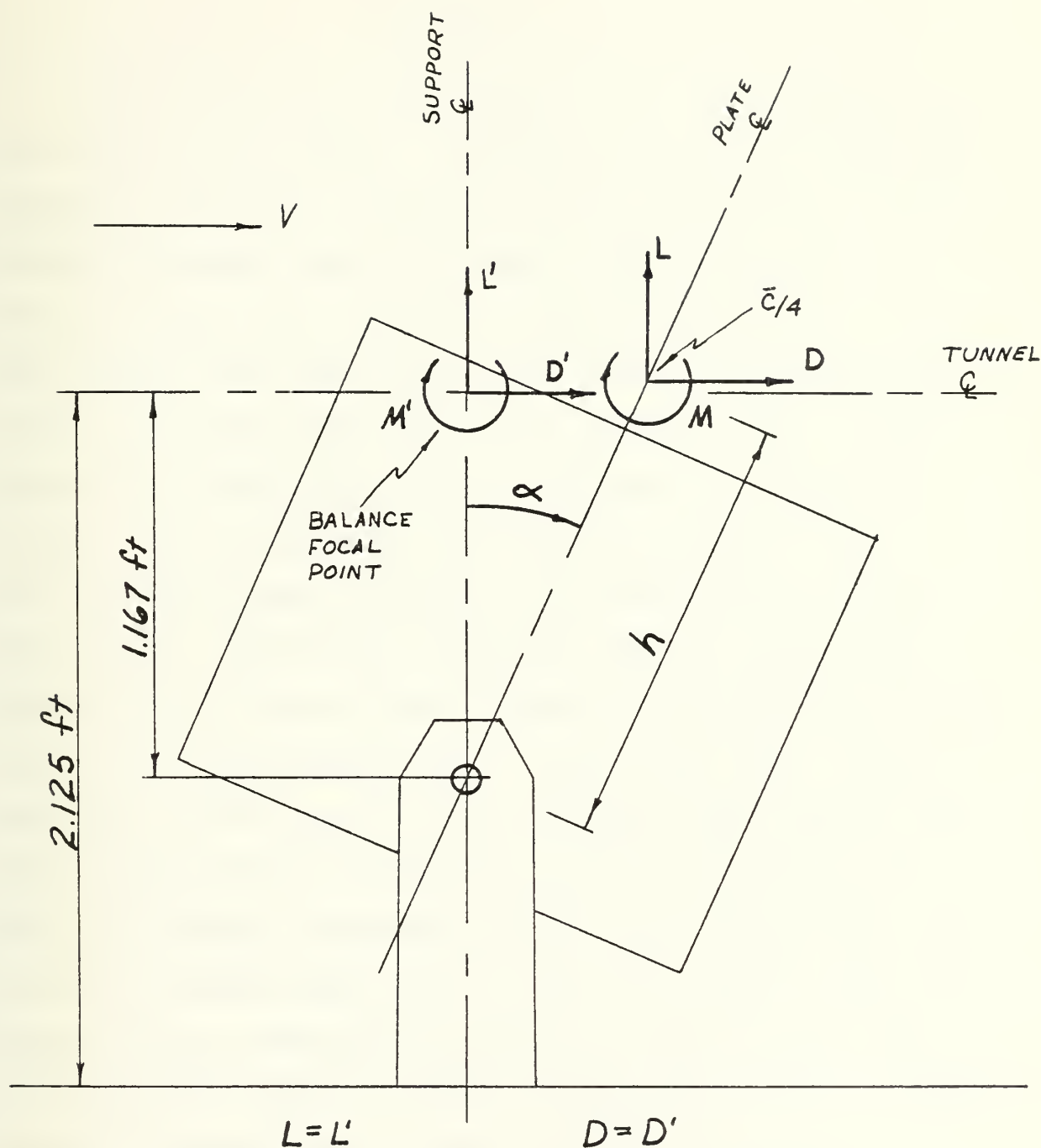
$$C_M = C_M' + (h \sin \alpha C_L + (1.1667 - h \cos \alpha) C_D) / \bar{c}$$

Note that the above equations are in non-dimensional form and those on the figures were in dimensional form for the purpose of clarity. Dividing the figure equations by $QS\bar{c}$ would yield equivalent non-dimensional relations.



$$M = M' - hD \cos \alpha + hL \sin \alpha$$

Figure 19. Three-strut moment transfer relations.



$$M = M' + h L \sin \alpha + (1.167 - h \cos \alpha) D$$

Figure 20. Centerplate moment transfer relations.

APPENDIX C

The following data was logged with a new microprocessor data acquisition system. The data variations in format and sequence represent a learning curve as familiarity with the system increased. Each run consists of a minimum of two wind-off zeros and 27 angle of attack conditions. Initial dead weight tares were taken at 21 conditions and two zero checks, but were later expanded to encompass the six extra check point conditions for fully redundant repeatability checks. The initial and final wind-off zeros for runs on the 18th of May were included in the calculation of each run's data. Thereafter, individual wind-off zeros were taken with each run or were repeated as the final and initial data rows in consecutive runs. Initial and final wind-on data rows for the runs of the 27th of May were checked for consistency and then dropped from reduction as the zero point was already redundant within the 27 reduced data rows. In initial weight tare runs for which the precise angle of attack was not required, the angle of attack values were rounded to the nearest integer to speed data entry. Slight deviation between raw data and computer storage values only reflects HP9830 computer rounding for fixed -4 format and not the stored value.

Wind-on to wind-off times for the 27 angle of attack positions settled to about eight minutes with manual angle of attack settings. Programmed microprocessor setting promises to reduce this interval by a factor of one half.

The computer file record of each data group immediately follows the respective raw data.

TABLE XII

RUN NO: 051501 .. 15 MAY 1977
3 STRUT SUPPORT CALIB. WING

READY
SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
030	-.6007	4.397	.5125	6.794E-02	.4039
031	-.4986	4.427	.4633	8.827E-02	.3751
032	-.3979	4.405	.4093	.1054	.3544
033	-.2978	4.358	.3591	.1195	.3329
034	-.1966	4.461	.3135	.1262	.3262
035	-9.753E-02	4.507	.2613	.1303	.3189
036	1.213E-03	4.470	.2111	.1340	.3142
037	.1016	4.427	.1585	.1348	.3125
038	.1970	4.474	.1135	.1321	.3161
039	.2990	4.510	6.167E-02	.1264	.3235
040	.4006	4.548	1.196E-02	.1169	.3347
041	.4994	4.583	-3.835E-02	.1047	.3528
042	.6012	4.530	-8.222E-02	8.964E-02	.3727
043	.7029	4.568	-.1358	7.084E-02	.3989
044	.8017	4.560	-.1777	3.720E-02	.4443
045	.8985	4.492	-.2082	-1.807E-02	.5228
046	.9999	4.461	-.2343	-.1020	.6419
047	1.104	4.381	-.2438	-.1905	.7706
048	1.207	4.370	-.2503	-.2829	.9039
049	1.301	4.400	-.2479	-.3637	1.021
050	1.400	4.291	-.2285	-.4160	1.098
051	.6013	4.485	-7.762E-02	9.221E-02	.3690
052	.3977	4.391	2.206E-02	.1200	.3316
053	.2003	4.402	.1144	.1340	.3130
054	4.343E-03	4.353	.2119	.1366	.3110
055	-.1984	4.197	.3090	.1319	.3164
056	-.3946	4.258	.4065	.1113	.3466
057	1.223E-03	-7.123E-03	.2062	.2029	.2051
058					

TABLE XIII

RUN NO: 51501

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0007	0.0006	0.2071	0.2035	0.2053
2	-0.6007	4.3970	0.5125	0.0679	0.4039
3	-0.4986	4.4270	0.4633	0.0083	0.3751
4	-0.3979	4.4050	0.4093	0.1054	0.3544
5	-0.2978	4.3580	0.3591	0.1195	0.3329
6	-0.1966	4.4610	0.3135	0.1262	0.3262
7	-0.0975	4.5070	0.2613	0.1303	0.3189
8	0.0012	4.4700	0.2111	0.1340	0.3142
9	0.1016	4.4270	0.1585	0.1348	0.3125
10	0.1970	4.4740	0.1135	0.1321	0.3161
11	0.2990	4.5100	0.0617	0.1264	0.3235
12	0.4006	4.5480	0.0120	0.1169	0.3347
13	0.4994	4.5830	-0.0384	0.1047	0.3528
14	0.6012	4.5300	-0.0822	0.0896	0.3727
15	0.7029	4.5680	-0.1358	0.0708	0.3989
16	0.8017	4.5600	-0.1777	0.0372	0.4443
17	0.8985	4.4920	-0.2082	-0.0181	0.5228
18	0.9999	4.4610	-0.2343	-0.1020	0.6419
19	1.1040	4.3810	-0.2438	-0.1905	0.7706
20	1.2070	4.3700	-0.2503	-0.2829	0.9039
21	1.3010	4.4000	-0.2479	-0.3637	1.0210
22	1.4000	4.2910	-0.2285	-0.4160	1.0980
23	0.6013	4.4850	-0.0776	0.0922	0.3690
24	0.3977	4.3910	0.0221	0.1200	0.3316
25	0.2003	4.4020	0.1144	0.1340	0.3130
26	0.0023	4.3530	0.2119	0.1366	0.3110
27	-0.1984	4.1970	0.3090	0.1319	0.3164
28	-0.3946	4.2580	0.4065	0.1113	0.3466
29	0.0012	-0.0071	0.2062	0.2029	0.2051

RUN # 51501 DATA IS STORED IN FILE# 8

TABLE XIV

RUN NO: STATIC CALIB. ... 15 MAY 1977 AT 1605

READY
SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
006	1.223E-03	1.242E-03	.2049	.2019	.2050
007	-.6034	1.223E-03	.2053	.2018	.2046
008	-.5001	1.232E-03	.2059	.2017	.2064
009	-.4000	1.223E-03	.2048	.2019	.2063
010	-.3018	1.223E-03	.2052	.2020	.2060
011	-.1968	1.223E-03	.2059	.2021	.2056
012	-9.770E-02	1.223E-03	.2056	.2024	.2043
013	-1.495E-03	1.223E-03	.2058	.2028	.2057
014	9.870E-02	1.223E-03	.2064	.2030	.2048
015	.2001	1.223E-03	.2057	.2035	.2067
016	.3019	1.223E-03	.2054	.2039	.2063
017	.4006	1.223E-03	.2059	.2044	.2048
018	.5020	1.223E-03	.2063	.2051	.2061
019	.6039	1.223E-03	.2062	.2058	.2053
020	.7003	1.194E-03	.2063	.2062	.2056
021	.8043	1.194E-03	.2065	.2066	.2035
022	.9034	1.137E-03	.2069	.2073	.2024
023	1.002	1.099E-03	.2067	.2084	.2031
024	1.100	1.070E-03	.2063	.2096	.2020
025	1.203	5.264E-04	.2063	.2104	.2005
026	1.300	7.648E-04	.2064	.2113	.2009
027	1.403	1.450E-04	.2062	.2124	.2005
028	7.362E-04	5.836E-04	.2071	.2035	.2053
029					

TABLE XV

RUN NO: 51577

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0000	0.0000	0.2049	0.2019	0.2050
2	-6.0000	0.0000	0.2053	0.2018	0.2046
3	-5.0000	0.0000	0.2059	0.2017	0.2064
4	-4.0000	0.0000	0.2048	0.2019	0.2063
5	-3.0000	0.0000	0.2052	0.2020	0.2060
6	-2.0000	0.0000	0.2059	0.2021	0.2056
7	-1.0000	0.0000	0.2056	0.2024	0.2043
8	0.0000	0.0000	0.2058	0.2028	0.2057
9	1.0000	0.0000	0.2064	0.2030	0.2048
10	2.0000	0.0000	0.2057	0.2035	0.2067
11	3.0000	0.0000	0.2054	0.2039	0.2063
12	4.0000	0.0000	0.2059	0.2044	0.2046
13	5.0000	0.0000	0.2063	0.2051	0.2061
14	6.0000	0.0000	0.2062	0.2058	0.2053
15	7.0000	0.0000	0.2063	0.2062	0.2056
16	8.0000	0.0000	0.2065	0.2066	0.2035
17	9.0000	0.0000	0.2069	0.2073	0.2024
18	10.0000	0.0000	0.2067	0.2084	0.2031
19	11.0000	0.0000	0.2063	0.2096	0.2020
20	12.0000	0.0000	0.2063	0.2104	0.2005
21	13.0000	0.0000	0.2064	0.2113	0.2009
22	14.0000	0.0000	0.2062	0.2124	0.2005
23	6.0000	0.0000	0.2062	0.2058	0.2053
24	4.0000	0.0000	0.2059	0.2044	0.2046
25	2.0000	0.0000	0.2057	0.2035	0.2067
26	0.0000	0.0000	0.2058	0.2028	0.2057
27	-2.0000	0.0000	0.2059	0.2021	0.2056
28	-4.0000	0.0000	0.2048	0.2019	0.2063
29	0.0000	0.0000	0.2071	0.2035	0.2053

RUN # 51577 DATA IS STOPED IN FILE# 7

TABLE XVI

RUN 51801, Q=40 PSF

e
READY
SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
037	-.5973	4.392	.5060	6.868E-02	.3980
038	-.4986	4.291	.4536	9.063E-02	.3675
039	-.3926	4.379	.4044	.1068	.3463
040	-.3979	4.387	.4081	.1065	.3462
041	-.2990	4.243	.3514	.1210	.3262
042	-.1966	4.240	.3044	.1291	.3157
043	-9.740E-02	4.402	.2611	.1319	.3118
044	1.232E-03	4.399	.2077	.1342	.3091
045	.1015	4.387	.1597	.1338	.3092
046	.2002	4.487	.1081	.1307	.3126
047	.3000	4.444	5.973E-02	.1263	.3178
048	.4007	4.481	1.063E-02	.1177	.3302
049	.4994	4.459	-3.304E-02	.1064	.3467
050	.6015	4.471	-8.295E-02	9.153E-02	.3675
051	.7004	4.454	-.1296	7.331E-02	.3906
052	.8007	4.497	-.1739	3.828E-02	.4381
053	.9008	4.451	-.2074	-1.848E-02	.5215
054	1.000	4.465	-.2376	-.1050	.6442
055	1.102	4.438	-.2523	-.1958	.7757
056	1.201	4.457	-.2647	-.2884	.9092
057	1.300	4.353	-.2516	-.3563	1.007
058	1.400	4.339	-.2289	-.4160	1.093
059	.5984	4.422	-7.739E-02	9.221E-02	.3648
060	.4007	4.496	1.222E-02	.1171	.3314
061	.2002	4.411	.1137	.1318	.3116
062	1.223E-03	4.386	.2046	.1341	.3091
063	-.1967	4.255	.3059	.1302	.3143
064	-.3979	4.351	.4101	.1073	.3477
065	1.223E-03	4.329	.2091	.1354	.3071
066					

TABLE XVII

RUN NO: 51801

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0012	0.0013	0.2035	0.2034	0.2034
2	-0.5973	4.3920	0.5060	0.0687	0.3990
3	-0.4986	4.2910	0.4536	0.0906	0.3675
4	-0.3979	4.3870	0.4081	0.1065	0.3462
5	-0.2990	4.2430	0.3514	0.1210	0.3262
6	-0.1966	4.2400	0.3044	0.1291	0.3157
7	-0.0974	4.4020	0.2611	0.1319	0.3110
8	0.0012	4.3990	0.2077	0.1342	0.3091
9	0.1015	4.3870	0.1597	0.1338	0.3092
10	0.2002	4.4870	0.1081	0.1307	0.3126
11	0.3000	4.4440	0.0597	0.1263	0.3178
12	0.4007	4.4810	0.0106	0.1177	0.3302
13	0.4994	4.4590	-0.0330	0.1064	0.3467
14	0.6015	4.4710	-0.0830	0.0915	0.3675
15	0.7004	4.4540	-0.1296	0.0733	0.3906
16	0.8007	4.4970	-0.1739	0.0583	0.4381
17	0.9008	4.4510	-0.2074	-0.0185	0.5215
18	1.0000	4.4650	-0.2376	-0.1050	0.6442
19	1.1020	4.4380	-0.2523	-0.1958	0.7757
20	1.2010	4.4570	-0.2647	-0.2884	0.9092
21	1.3000	4.3530	-0.2516	-0.3563	1.0070
22	1.4000	4.3390	-0.2289	-0.4160	1.0930
23	0.5984	4.4220	-0.0774	0.0922	0.3648
24	0.4007	4.4960	0.0122	0.1171	0.3314
25	0.2002	4.4110	0.1137	0.1318	0.3116
26	0.0012	4.3860	0.2046	0.1341	0.3091
27	-0.1967	4.2550	0.3059	0.1302	0.3143
28	-0.3979	4.3510	0.4101	0.1073	0.3477
29	0.0012	0.0166	0.2015	0.2021	0.2033

RUN # 51801 DATA IS STORED IN FILE# 10

TABLE XVIII

RUN 51802, Q=30 PSF

0
READY
SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
067	-.5947	3.242	.4246	.1060	.3440
068	-.4963	3.207	.3883	.1210	.3213
069	-.3978	3.184	.3526	.1345	.3047
070	-.2992	3.238	.3145	.1423	.2938
071	-.1967	3.178	.2754	.1498	.2833
072	-9.757E-02	3.214	.2429	.1529	.2785
073	1.165E-03	3.254	.2075	.1546	.2755
074	.1015	3.182	.1699	.1553	.2747
075	.2002	3.288	.1312	.1525	.2787
076	.2991	3.285	9.801E-02	.1482	.2849
077	.4005	3.289	6.402E-02	.1415	.2934
078	.5008	3.293	2.374E-02	.1330	.3057
079	.5984	3.320	-9.879E-03	.1228	.3207
080	.7005	3.288	-4.445E-02	.1079	.3419
081	.7994	3.256	-7.017E-02	8.226E-02	.3761
082	.9038	3.309	-.1009	3.514E-02	.4397
083	1.003	3.294	-.1202	-2.544E-02	.5317
084	1.099	3.240	-.1308	-8.801E-02	.6225
085	1.201	3.221	-.1322	-.1511	.7141
086	1.298	3.240	-.1326	-.2111	.8002
087	1.400	3.259	-.1259	-.2646	.8783
088	.5982	3.313	-7.171E-03	.1229	.3214
089	.4007	3.272	6.359E-02	.1426	.2939
090	.2002	3.320	.1370	.1519	.2826
091	1.223E-03	3.309	.2078	.1539	.2793
092	-.1966	3.294	.2797	.1490	.2863
093	-.3979	3.260	.3575	.1328	.3072
094					

TABLE XIX

RUN NO: 51802

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0012	0.0013	0.2035	0.2034	0.2034
2	-0.5947	3.2420	0.4246	0.1060	0.3440
3	-0.4963	3.2070	0.3883	0.1210	0.3213
4	-0.3978	3.1840	0.3526	0.1345	0.3047
5	-0.2992	3.2380	0.3145	0.1423	0.2938
6	-0.1967	3.1780	0.2754	0.1498	0.2833
7	-0.0976	3.2140	0.2429	0.1529	0.2785
8	0.0012	3.2540	0.2075	0.1546	0.2755
9	0.1015	3.1820	0.1699	0.1553	0.2747
10	0.2002	3.2880	0.1312	0.1525	0.2787
11	0.2991	3.2850	0.0980	0.1482	0.2849
12	0.4005	3.2890	0.0640	0.1415	0.2934
13	0.5008	3.2930	0.0237	0.1330	0.3057
14	0.5984	3.3200	-0.0099	0.1228	0.3207
15	0.7005	3.2880	-0.0445	0.1079	0.3419
16	0.7994	3.2560	-0.0702	0.0823	0.3761
17	0.9038	3.3090	-0.1009	0.0351	0.4397
18	1.0030	3.2940	-0.1202	-0.0254	0.5317
19	1.0990	3.3400	-0.1308	-0.0880	0.6225
20	1.2010	3.2210	-0.1322	-0.1511	0.7141
21	1.2980	3.2400	-0.1326	-0.2111	0.8002
22	1.4000	3.2590	-0.1259	-0.2646	0.8783
23	0.5982	3.3130	-0.0072	0.1229	0.3214
24	0.4007	3.2720	0.0636	0.1426	0.2939
25	0.2002	3.3200	0.1370	0.1519	0.2826
26	0.0012	3.3090	0.2078	0.1539	0.2793
27	-0.1966	3.2940	0.2797	0.1490	0.2863
28	-0.3979	3.2600	0.3575	0.1328	0.3072
29	0.0012	0.0166	0.2015	0.2021	0.2033

RUN # 51802 DATA IS STORED IN FILE# 11

TABLE XX

RUN 51803, Q=20 PSF

Q
READY
SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
095	-.5974	2.164	.3586	.1423	.2915
096	-.4962	2.194	.3356	.1503	.2796
097	-.3979	2.230	.3149	.1570	.2719
098	-.2992	2.185	.2861	.1643	.2601
099	-.1966	2.171	.2610	.1693	.2543
000	-9.751E-02	2.213	.2341	.1706	.2522
001	1.223E-03	2.221	.2096	.1715	.2522
002	9.852E-02	2.230	.1850	.1711	.2516
003	.1997	2.239	.1568	.1700	.2524
004	.2991	2.217	.1341	.1672	.2559
005	.3992	2.231	.1105	.1624	.2618
006	.4994	2.255	8.094E-02	.1569	.2710
007	.6014	2.217	6.025E-02	.1503	.2793
008	.7003	2.263	3.254E-02	.1381	.2961
009	.8018	2.214	1.452E-02	.1196	.3208
010	.9005	2.244	6.504E-04	9.240E-02	.3573
011	1.0000	2.254	-1.678E-02	4.410E-02	.4272
012	1.100	2.186	-1.699E-02	4.942E-03	.4857
013	1.201	2.201	-2.224E-02	-3.561E-02	.5487
014	1.301	2.200	-2.173E-02	-7.521E-02	.6077
015	1.400	2.208	-1.462E-02	-.1074	.6547
016	.6015	2.239	5.906E-02	.1505	.2801
017	.4005	2.219	.1076	.1642	.2603
018	.2001	2.228	.1617	.1699	.2530
019	1.223E-03	2.208	.2107	.1721	.2506
020	-.1965	2.228	.2632	.1686	.2558
021	-.3978	2.183	.3136	.1579	.2696
022	1.223E-03	1.639E-02	.2017	.2013	.2027
023					
024	1.223E-03	1.662E-02	.2015	.2021	.2033

TABLE XXI

RUN NO: 51883

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0012	0.0013	0.2035	0.2034	0.2034
2	-0.5974	2.1640	0.3586	0.1423	0.2915
3	-0.4962	2.1940	0.3356	0.1503	0.2796
4	-0.3979	2.2300	0.3149	0.1570	0.2719
5	-0.2992	2.1850	0.2861	0.1643	0.2601
6	-0.1966	2.1710	0.2610	0.1693	0.2543
7	-0.0975	2.2130	0.2341	0.1706	0.2522
8	0.0012	2.2210	0.2096	0.1715	0.2522
9	0.0985	2.2300	0.1850	0.1711	0.2516
10	0.1997	2.2390	0.1568	0.1700	0.2524
11	0.2991	2.2170	0.1341	0.1672	0.2559
12	0.3992	2.2310	0.1105	0.1624	0.2618
13	0.4994	2.2550	0.0809	0.1569	0.2710
14	0.6014	2.2170	0.0603	0.1503	0.2793
15	0.7003	2.2630	0.0325	0.1381	0.2961
16	0.8018	2.2140	0.0145	0.1196	0.3208
17	0.9005	2.2440	0.0007	0.0924	0.3573
18	1.0000	2.2540	-0.0168	0.0441	0.4272
19	1.1000	2.1860	-0.0170	0.0049	0.4857
20	1.2010	2.2010	-0.0222	-0.0356	0.5487
21	1.3010	2.2000	-0.0217	-0.0752	0.6077
22	1.4000	2.2080	-0.0146	-0.1074	0.6547
23	0.6015	2.2390	0.0591	0.1505	0.2801
24	0.4005	2.2190	0.1076	0.1642	0.2603
25	0.2001	2.2280	0.1617	0.1699	0.2530
26	0.0012	2.2080	0.2107	0.1721	0.2506
27	-0.1965	2.2280	0.2632	0.1686	0.2558
28	-0.3978	2.1830	0.3136	0.1579	0.2696
29	0.0012	0.0166	0.2015	0.2021	0.2033

RUN # 51883 DATA IS STORED IN FILE# 12

TABLE XXII

18 MAY 1977 WIND OFF BALANCE READINGS 1500

DE
READY
SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
006	1.223E-03	1.223E-03	.2010	.2019	.2032
007	-.6006	1.223E-03	.2014	.2015	.2038
008	-.4986	1.223E-03	.2012	.2015	.2034
009	-.3997	1.223E-03	.2014	.2017	.2041
010	-.2987	1.223E-03	.2016	.2016	.2054
011	-.1995	1.223E-03	.2019	.2020	.2034
012	-9.728E-02	1.232E-03	.2022	.2023	.2042
013	1.223E-03	1.223E-03	.2026	.2028	.2031
014	.1016	1.223E-03	.2019	.2029	.2030
015	.2001	1.232E-03	.2019	.2035	.2020
016	.2992	1.242E-03	.2030	.2042	.2025
017	.4007	1.223E-03	.2021	.2045	.2022
018	.4994	1.223E-03	.2030	.2052	.2017
019	.6021	1.270E-03	.2032	.2059	.2024
020	.7003	1.280E-03	.2025	.2062	.2017
021	.7998	1.242E-03	.2028	.2068	.2005
022	.9009	1.280E-03	.2033	.2077	.2001
023	1.000	1.261E-03	.2026	.2086	.2007
024	1.100	1.251E-03	.2030	.2095	.1990
025	1.201	1.404E-03	.2035	.2107	.1977
026	1.300	1.299E-03	.2023	.2113	.1979
027	1.400	1.308E-03	.2028	.2124	.1964
028	.5982	1.289E-03	.2034	.2059	.2011
029	.3698	1.337E-03	.2034	.2048	.2021
030	.4006	1.337E-03	.2031	.2048	.2020
031	.2001	1.337E-03	.2027	.2039	.2023
032	1.223E-03	1.299E-03	.2029	.2033	.2027
033	-.1967	1.337E-03	.2024	.2025	.2025
034	-.3977	1.537E-03	.2017	.2027	.2030
035	1.232E-03	1.308E-03	.2035	.2034	.2034
036					

TABLE XXIII

RUN NO: 51877

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0000	0.0000	0.2010	0.2019	0.2032
2	-6.0000	0.0000	0.2014	0.2015	0.2036
3	-5.0000	0.0000	0.2012	0.2015	0.2034
4	-4.0000	0.0000	0.2014	0.2017	0.2041
5	-3.0000	0.0000	0.2016	0.2016	0.2054
6	-2.0000	0.0000	0.2019	0.2020	0.2034
7	-1.0000	0.0000	0.2022	0.2023	0.2042
8	0.0000	0.0000	0.2026	0.2028	0.2031
9	1.0000	0.0000	0.2019	0.2029	0.2030
10	2.0000	0.0000	0.2019	0.2035	0.2020
11	3.0000	0.0000	0.2030	0.2042	0.2025
12	4.0000	0.0000	0.2021	0.2045	0.2022
13	5.0000	0.0000	0.2030	0.2052	0.2017
14	6.0000	0.0000	0.2032	0.2059	0.2024
15	7.0000	0.0000	0.2025	0.2062	0.2017
16	8.0000	0.0000	0.2028	0.2068	0.2005
17	9.0000	0.0000	0.2033	0.2077	0.2001
18	10.0000	0.0000	0.2026	0.2086	0.2007
19	11.0000	0.0000	0.2030	0.2095	0.1190
20	12.0000	0.0000	0.2035	0.2107	0.1977
21	13.0000	0.0000	0.2023	0.2113	0.1979
22	14.0000	0.0000	0.2028	0.2124	0.1964
23	6.0000	0.0000	0.2034	0.2059	0.2011
24	4.0000	0.0000	0.2031	0.2048	0.2020
25	2.0000	0.0000	0.2027	0.2039	0.2023
26	0.0000	0.0000	0.2029	0.2033	0.2027
27	-2.0000	0.0000	0.2024	0.2025	0.2025
28	-4.0000	0.0000	0.2017	0.2027	0.2030
29	0.0000	0.0000	0.2035	0.2034	0.2034

RUN # 51877 DATA IS STORED IN FILE# 9

TABLE XXIV

RUN 052602 ON 26 MAY 1977

PLATE PLUS FAIRING (WING OFF)

NOMINAL Q= 40 PSF

②

> SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
064	.0122	.0158	.0079	.0042	.0012
065	.0122	4.475	-.0024	-.0239	.0418
066	-5.971	4.467	-.0026	.0014	.0218
067	-4.982	4.441	-.0030	-.0004	.0268
068	-3.973	4.480	-.0011	-.0054	.0311
069	-2.979	4.396	-.0018	-.0098	.0330
070	-1.989	4.410	-.0022	-.0145	.0360
071	-.9666	4.353	-.0037	-.0194	.0380
072	.0122	4.438	-.0045	-.0251	.0419
073	.9912	4.373	-.0042	-.0290	.0458
074	2.005	4.383	-.0044	-.0334	.0465
075	2.994	4.441	-.0031	-.0379	.0517
076	4.001	4.411	-.0035	-.0422	.0544
077	4.999	4.409	-.0046	-.0456	.0562
078	5.990	4.398	-.0050	-.0498	.0593
079	6.984	4.383	-.0062	-.0539	.0624
080	7.998	4.380	-.0059	-.0572	.0641
081	9.001	4.322	-.0064	-.0607	.0670
082	10.01	4.447	-.0063	-.0656	.0719
083	11.00	4.408	-.0073	-.0690	.0736
084	11.99	4.381	-.0079	-.0729	.0771
085	12.99	4.357	-.0078	-.0764	.0800
086	13.98	4.373	-.0082	-.0800	.0835
087	5.000	4.402	-.0042	-.0493	.0593
088	3.034	4.398	-.0034	-.0411	.0535
089	1.977	4.343	-.0023	-.0324	.0469
090	.0122	4.427	-.0018	-.0233	.0419
091	-1.988	4.344	-.0017	-.0132	.0337
092	-3.970	4.367	-.0013	-.0046	.0279
093	.0122	4.346	-.0016	-.0234	.0412
094	.0122	.0203	.0065	.0020	.0012

TABLE XXV

RUN NO: 52602

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0122	0.0158	0.0079	0.0042	0.0012
2	-5.9710	4.4670	-0.0026	0.0014	0.0218
3	-4.9820	4.4410	-0.0030	-0.0004	0.0268
4	-3.9730	4.4000	-0.0011	-0.0054	0.0311
5	-2.9790	4.3960	-0.0018	-0.0098	0.0330
6	-1.9890	4.4100	-0.0022	-0.0145	0.0360
7	-0.9666	4.3530	-0.0037	-0.0194	0.0380
8	0.0122	4.4380	-0.0045	-0.0251	0.0419
9	0.9912	4.3730	-0.0042	-0.0290	0.0458
10	2.0050	4.3830	-0.0044	-0.0334	0.0465
11	2.9940	4.4410	-0.0031	-0.0379	0.0517
12	4.0010	4.4110	-0.0035	-0.0422	0.0544
13	4.9990	4.4090	-0.0046	-0.0456	0.0562
14	5.9900	4.3980	-0.0050	-0.0498	0.0593
15	6.9840	4.3830	-0.0062	-0.0539	0.0624
16	7.9950	4.3800	-0.0059	-0.0572	0.0641
17	9.0010	4.3220	-0.0064	-0.0607	0.0670
18	10.0100	4.4470	-0.0063	-0.0656	0.0719
19	11.0000	4.4080	-0.0073	-0.0690	0.0736
20	11.9900	4.3810	-0.0079	-0.0729	0.0771
21	12.9900	4.3570	-0.0078	-0.0764	0.0800
22	13.9800	4.3730	-0.0082	-0.0800	0.0835
23	5.9900	4.4020	-0.0042	-0.0493	0.0593
24	3.9840	4.3980	-0.0034	-0.0411	0.0535
25	1.9770	4.3430	-0.0023	-0.0324	0.0469
26	0.0122	4.4270	-0.0018	-0.0233	0.0419
27	-1.9880	4.3440	-0.0017	-0.0132	0.0337
28	-3.9700	4.3670	-0.0013	-0.0046	0.0279
29	0.0122	0.0203	0.0065	0.0020	0.0012

RUN # 52602 DATA IS STORED IN FILE# 5

TABLE XXVI

RUN 052603 ON 26 MAY 1977
 PLATE PLUS FAIRING (WING OFF)
 NOMINAL Q= 30 PSF

Q

> SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
095	.0122	.0187	.0056	.0012	.0012
096	.0122	3.249	-.0006	-.0184	.0316
097	-5.968	3.228	-.0009	.0035	.0133
098	-4.981	3.283	-.0016	.0012	.0173
099	-3.983	3.210	-.0009	-.0007	.0202
100	-2.979	3.263	-.0002	-.0059	.0235
101	-1.984	3.282	-.0014	-.0102	.0253
102	-.9658	3.236	-.0010	-.0146	.0297
103	.0122	3.287	-.0004	-.0186	.0321
104	.9927	3.325	-.0005	-.0242	.0353
105	2.011	3.244	.0005	-.0275	.0369
106	2.999	3.241	-.0009	-.0311	.0401
107	3.988	3.198	-.0010	-.0353	.0428
108	5.002	3.272	-.0017	-.0391	.0467
109	5.994	3.246	-.0015	-.0427	.0484
110	6.988	3.224	-.0014	-.0463	.0513
111	8.002	3.235	-.0026	-.0507	.0550
112	8.997	3.214	-.0030	-.0545	.0578
113	10.01	3.281	-.0033	-.0585	.0610
114	11.00	3.302	-.0040	-.0625	.0632
115	12.00	3.234	-.0045	-.0661	.0656
116	13.00	3.300	-.0047	-.0702	.0689
117	13.98	3.209	-.0059	-.0734	.0703
118	5.994	3.236	-.0015	-.0435	.0491
119	3.988	3.197	-.0004	-.0359	.0425
120	1.982	3.245	-.0004	-.0278	.0369
121	.0122	3.252	-.0009	-.0185	.0318
122	-1.984	3.273	.0002	-.0104	.0258
123	-3.992	3.269	.0004	-.0011	.0199
124	.0122	3.204	-.0012	-.0186	.0309
125	.0122	.0211	.0054	.0012	.0012

TABLE XXVII

RUN NO: 52603

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0122	0.0137	0.0056	0.0012	0.0012
2	-5.9680	3.2280	-0.0009	0.0035	0.0133
3	-4.9810	3.2830	-0.0016	0.0012	0.0173
4	-3.9830	3.2100	-0.0009	-0.0007	0.0202
5	-2.9790	3.2630	-0.0002	-0.0059	0.0235
6	-1.9840	3.2820	-0.0014	-0.0102	0.0253
7	-0.9658	3.2360	-0.0010	-0.0146	0.0297
8	0.0122	3.2870	-0.0004	-0.0186	0.0321
9	0.9927	3.3250	-0.0005	-0.0242	0.0353
10	2.0110	3.2440	0.0005	-0.0275	0.0369
11	2.9990	3.2410	-0.0009	-0.0311	0.0401
12	3.9880	3.1980	-0.0010	-0.0353	0.0428
13	5.0020	3.2720	-0.0017	-0.0391	0.0457
14	5.9940	3.2460	-0.0015	-0.0427	0.0484
15	6.9880	3.2240	-0.0014	-0.0463	0.0513
16	8.0020	3.2350	-0.0026	-0.0507	0.0550
17	8.9970	3.2140	-0.0030	-0.0545	0.0578
18	10.0100	3.2810	-0.0033	-0.0585	0.0610
19	11.0000	3.3020	-0.0040	-0.0625	0.0632
20	12.0000	3.2340	-0.0045	-0.0661	0.0656
21	13.0000	3.3000	-0.0047	-0.0702	0.0689
22	13.9800	3.2090	-0.0059	-0.0734	0.0703
23	5.9940	3.2360	-0.0015	-0.0435	0.0491
24	3.9880	3.1970	-0.0004	-0.0359	0.0425
25	1.9820	3.2450	-0.0004	-0.0278	0.0369
26	0.0122	3.2520	-0.0009	-0.0185	0.0318
27	-1.9840	3.2730	0.0002	-0.0104	0.0258
28	-3.9920	3.2690	0.0004	-0.0011	0.0199
29	0.0122	0.0211	0.0054	0.0012	0.0012

RUN # 52603 DATA IS STORED IN FILE# 6

TABLE XXVIII

RUN 052601 QN 26 MAY 1977
 PLATE PLUS FAIRING (WING OFF)
 NOMINAL Q= 20 PSF

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> SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
033	.0122	.0124	.0067	.0024	.0012
034	.0122	2.175	.0012	-.0104	.0199
035	-5.974	2.176	.0012	.0115	.0030
036	-4.984	2.192	.0013	.0076	.0050
037	-3.995	2.207	.0013	.0031	.0090
038	-2.982	2.186	.0012	.0012	.0112
039	-1.992	2.175	.0016	.0000	.0142
040	-.9688	2.184	.0014	-.0048	.0176
041	.0122	2.187	.0012	-.0091	.0206
042	.9910	2.167	.0016	-.0123	.0233
043	2.006	2.154	.0015	-.0168	.0277
044	2.994	2.191	.0019	-.0199	.0312
045	3.984	2.171	.0029	-.0238	.0338
046	4.998	2.194	.0021	-.0277	.0354
047	5.990	2.142	.0016	-.0308	.0372
048	6.984	2.184	.0018	-.0349	.0390
049	7.998	2.152	.0021	-.0378	.0410
050	9.002	2.163	.0013	-.0415	.0442
051	10.01	2.182	.0016	-.0452	.0457
052	10.99	2.178	.0014	-.0484	.0486
053	12.00	2.165	.0014	-.0517	.0507
054	12.99	2.162	.0013	-.0556	.0545
055	13.98	2.195	.0012	-.0585	.0564
056	5.991	2.189	.0015	-.0311	.0365
057	3.985	2.149	.0022	-.0231	.0323
058	1.977	2.163	.0020	-.0157	.0266
059	.0122	2.174	.0021	-.0080	.0202
060	-1.989	2.213	.0018	.0011	.0132
061	-3.993	2.188	.0017	.0047	.0079
062	.0122	2.176	.0018	-.0081	.0209
063	.0122	.0164	.0076	.0043	.0012

TABLE XXIX

RUN NO: 52601

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0122	0.0124	0.0067	0.0024	0.0012
2	-5.9740	2.1760	0.0012	0.0115	0.0030
3	-4.9840	2.1920	0.0013	0.0076	0.0050
4	-3.9950	2.2070	0.0013	0.0031	0.0090
5	-2.9820	2.1860	0.0012	0.0012	0.0112
6	-1.9920	2.1750	0.0016	0.0000	0.0142
7	-0.9688	2.1840	0.0014	-0.0048	0.0176
8	0.0122	2.1870	0.0012	-0.0091	0.0206
9	0.9910	2.1670	0.0016	-0.0123	0.0233
10	2.0060	2.1540	0.0015	-0.0168	0.0277
11	2.9940	2.1910	0.0019	-0.0199	0.0312
12	3.9840	2.1710	0.0029	-0.0238	0.0338
13	4.9980	2.1940	0.0021	-0.0277	0.0354
14	5.9900	2.1420	0.0016	-0.0308	0.0372
15	6.9840	2.1840	0.0018	-0.0349	0.0390
16	7.9980	2.1520	0.0021	-0.0378	0.0410
17	9.0020	2.1630	0.0013	-0.0415	0.0442
18	10.0100	2.1820	0.0016	-0.0452	0.0457
19	10.9900	2.1780	0.0014	-0.0484	0.0486
20	12.0000	2.1650	0.0014	-0.0517	0.0507
21	12.9900	2.1620	0.0013	-0.0556	0.0545
22	13.9800	2.1950	0.0012	-0.0585	0.0564
23	5.9910	2.1890	0.0015	-0.0311	0.0365
24	3.9850	2.1490	0.0022	-0.0231	0.0323
25	1.9770	2.1630	0.0020	-0.0157	0.0266
26	0.0122	2.1740	0.0021	-0.0080	0.0202
27	-1.9890	2.2130	0.0018	0.0011	0.0132
28	-3.9930	2.1880	0.0017	0.0047	0.0079
29	0.0122	0.0164	0.0076	0.0043	0.0012

RUN # 52601 DATA IS STORED IN FILE# 4

TABLE XXX

1620 ON 26 MAY 1977

.. STATIC WEIGHT TAKE, WIND-OFF..

.. PLATE PLUS FAIRING (WIND-OFF)

⑨

> SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
004	.0122	.0037	.0014	.0012	.0011
005	-5.993	.0035	.0012	.0201	-.0134
006	-4.985	.0048	.0020	.0181	-.0117
007	-3.979	.0059	.0017	.0151	-.0102
008	-2.976	.0064	.0029	.0114	-.0076
009	-1.992	.0065	.0036	.0081	-.0041
010	-1.005	.0066	.0027	.0048	-.0029
011	-.0047	.0061	.0038	.0014	.0010
012	.9893	.0060	.0030	.0012	.0012
013	1.975	.0062	.0041	-.0020	.0014
014	2.983	.0064	.0039	-.0061	.0049
015	3.982	.0067	.0047	-.0088	.0060
016	4.998	.0066	.0030	-.0133	.0090
017	5.988	.0072	.0042	-.0166	.0112
018	6.984	.0079	.0045	-.0183	.0133
019	7.998	.0079	.0049	-.0216	.0150
020	8.991	.0077	.0052	-.0247	.0158
021	9.978	.0083	.0047	-.0278	.0190
022	11.00	.0084	.0050	-.0304	.0201
023	12.01	.0092	.0047	-.0338	.0220
024	12.99	.0093	.0049	-.0366	.0253
025	14.01	.0094	.0047	-.0382	.0264
026	5.986	.0099	.0062	-.0138	.0111
027	3.981	.0100	.0057	-.0073	.0062
028	1.975	.0098	.0059	.0012	.0025
029	.0120	.0101	.0063	.0037	.0012
030	-1.991	.0100	.0063	.0106	-.0034
031	-3.977	.0107	.0059	.0185	-.0081
032	.0122	.0109	.0076	.0043	.0012

TABLE XXXI

RUN NO: 52677

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0122	0.0037	0.0014	0.0012	0.0011
2	-5.9930	0.0035	0.0012	0.0201	-0.0134
3	-4.9850	0.0048	0.0020	0.0181	-0.0117
4	-3.9790	0.0059	0.0017	0.0151	-0.0102
5	-2.9760	0.0064	0.0029	0.0114	-0.0076
6	-1.9920	0.0065	0.0036	0.0081	-0.0041
7	-1.0050	0.0066	0.0027	0.0048	-0.0029
8	-0.0047	0.0061	0.0038	0.0014	0.0010
9	0.9893	0.0060	0.0030	0.0012	0.0012
10	1.9750	0.0062	0.0041	-0.0020	0.0014
11	2.9830	0.0064	0.0039	-0.0061	0.0049
12	3.9820	0.0067	0.0047	-0.0088	0.0060
13	4.9980	0.0066	0.0030	-0.0133	0.0030
14	5.9880	0.0072	0.0042	-0.0166	0.0112
15	6.9840	0.0079	0.0045	-0.0183	0.0133
16	7.9980	0.0079	0.0049	-0.0216	0.0150
17	8.9910	0.0077	0.0052	-0.0247	0.0158
18	9.9780	0.0083	0.0047	-0.0278	0.0190
19	11.0000	0.0084	0.0050	-0.0304	0.0201
20	12.0100	0.0092	0.0047	-0.0338	0.0220
21	12.9900	0.0093	0.0049	-0.0366	0.0253
22	14.0100	0.0094	0.0047	-0.0382	0.0264
23	5.9860	0.0099	0.0062	-0.0138	0.0111
24	3.9810	0.0100	0.0057	-0.0073	0.0062
25	1.9750	0.0098	0.0059	0.0012	0.0025
26	0.0120	0.0101	0.0063	0.0037	0.0012
27	-1.9910	0.0100	0.0063	0.0106	-0.0034
28	-3.9770	0.0107	0.0059	0.0185	-0.0081
29	0.0122	0.0109	0.0076	0.0043	0.0012

RUN # 52677 DATA IS STORED IN FILE# 3

XXXII

RUN 052703 ON 27 MAY 1977
 PLATE PLUS FAIRING AND WING
 NOMINAL Q= 40 PSF

SC@
 > SCNA

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
092	.0122	.2229	.0052	.0063	.0019
093	.0122	41.02	.0066	-.0462	.0800
094	-5.948	39.55	.3015	.0254	.0649
095	-4.962	39.89	.2561	.0120	.0615
096	-3.962	39.56	.2026	.0005	.0620
097	-2.956	40.23	.1487	-.0134	.0656
098	-1.960	40.13	.1031	-.0234	.0662
099	-.9533	39.97	.0552	-.0353	.0723
100	.0122	40.69	.0079	-.0455	.0798
101	1.015	40.79	-.0392	-.0530	.0839
102	2.002	40.86	-.0925	-.0573	.0905
103	3.022	40.82	-.1424	-.0607	.0978
104	4.010	40.68	-.1872	-.0635	.1075
105	5.026	40.96	-.2393	-.0645	.1175
106	6.016	41.27	-.2892	-.0658	.1320
107	7.010	40.85	-.3339	-.0704	.1533
108	8.022	40.98	-.3756	-.0858	.1891
109	9.013	41.47	-.4239	-.1228	.2630
110	10.03	40.86	-.4517	-.1800	.3664
111	11.02	40.88	-.4762	-.2431	.4788
112	12.02	40.59	-.4874	-.3096	.5928
113	13.01	40.00	-.4844	-.3767	.7027
114	14.01	40.23	-.4834	-.4371	.8013
115	6.018	41.15	-.2862	-.0670	.1341
116	4.011	40.56	-.1875	-.0629	.1084
117	2.017	41.01	-.0894	-.0573	.0920
118	.0122	41.27	.0119	-.0449	.0803
119	-1.961	40.10	.1073	-.0221	.0674
120	-3.978	40.59	.2092	.0006	.0636
121	.0122	40.17	.0089	-.0429	.0792
122	.0122	.2811	.0012	.0057	.0012

TABLE XXXIII

RUN NO: 52703

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0122	0.2229	0.0052	0.0063	0.0019
2	-5.9480	39.5500	0.3015	0.0254	0.0649
3	-4.9620	39.8900	0.2561	0.0120	0.0615
4	-3.9620	39.5600	0.2026	0.0005	0.0620
5	-2.9560	40.2300	0.1487	-0.0134	0.0656
6	-1.9600	40.1300	0.1031	-0.0234	0.0662
7	-0.9533	39.9700	0.0552	-0.0353	0.0723
8	0.0122	40.6900	0.0079	-0.0455	0.0798
9	1.0150	40.7900	-0.0392	-0.0530	0.0839
10	2.0020	40.8600	-0.0925	-0.0573	0.0905
11	3.0220	40.8200	-0.1424	-0.0607	0.0978
12	4.0100	40.6800	-0.1872	-0.0635	0.1075
13	5.0260	40.9600	-0.2393	-0.0645	0.1175
14	6.0160	41.2700	-0.2892	-0.0658	0.1320
15	7.0100	40.8500	-0.3339	-0.0704	0.1533
16	8.0220	40.9800	-0.3756	-0.0858	0.1891
17	9.0130	41.4700	-0.4239	-0.1228	0.2630
18	10.0300	40.8600	-0.4517	-0.1800	0.3664
19	11.0200	40.8800	-0.4762	-0.2431	0.4788
20	12.0200	40.5900	-0.4874	-0.3096	0.5928
21	13.0100	40.0000	-0.4844	-0.3767	0.7027
22	14.0100	40.2300	-0.4834	-0.4371	0.8013
23	6.0180	41.1500	-0.2862	-0.0670	0.1341
24	4.0110	40.5600	-0.1875	-0.0629	0.1084
25	3.0170	41.0100	-0.0894	-0.0573	0.0920
26	0.0122	41.2700	0.0119	-0.0449	0.0803
27	-1.9610	40.1000	0.1073	-0.0221	0.0674
28	-0.9780	40.5900	0.2092	0.0006	0.0636
29	0.0122	0.2811	0.0012	0.0057	0.0012

RUN # 52703 DATA IS STORED IN FILE# 10

TABLE XXXIV

RUN 052702 ON 27 MAY 1977
 PLATE PLUS FAIRING AND WING
 NOMINAL Q= 30 PSF

2
 > SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
061	.0122	.1835	.0046	.0049	.0012
062	.0122	30.97	.0032	-.0343	.0608
063	-5.948	30.15	.2277	.0270	.0449
064	-4.962	30.89	.1965	.0132	.0468
065	-3.945	30.30	.1549	.0036	.0442
066	-2.955	30.68	.1170	-.0037	.0455
067	-1.960	30.39	.0758	-.0151	.0504
068	-.9538	30.53	.0419	-.0246	.0548
069	.0122	30.73	.0040	-.0343	.0612
070	.9997	30.59	-.0322	-.0402	.0664
071	2.005	30.60	-.0734	-.0451	.0718
072	3.023	30.75	-.1106	-.0516	.0768
073	4.009	30.76	-.1475	-.0540	.0843
074	5.027	30.87	-.1829	-.0569	.0945
075	6.017	30.97	-.2232	-.0573	.1055
076	7.008	30.78	-.2520	-.0639	.1252
077	8.022	30.75	-.2893	-.0808	.1600
078	9.012	30.62	-.3134	-.1083	.2096
079	10.02	30.58	-.3399	-.1531	.2906
080	11.02	30.55	-.3563	-.2017	.3754
081	12.02	30.57	-.3670	-.2554	.4665
082	13.01	30.12	-.3631	-.3036	.5426
083	14.01	30.45	-.3683	-.3531	.6267
084	6.017	30.54	-.2189	-.0563	.1059
085	4.010	30.90	-.1449	-.0522	.0851
086	2.005	30.40	-.0647	-.0458	.0726
087	.0122	30.75	.0052	-.0335	.0619
088	-1.962	30.73	.0821	-.0144	.0513
089	-3.979	30.36	.1579	.0044	.0436
090	.0122	30.11	.0064	-.0326	.0604
091	.0122	.2240	.0038	.0054	.0014

TABLE XXXV

RUN NO: 52702

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0122	0.1835	0.0046	0.0049	0.0012
2	-5.9480	30.1500	0.2277	0.0270	0.0449
3	-4.9620	30.2900	0.1965	0.0132	0.0468
4	-3.9450	30.3000	0.1549	0.0036	0.0442
5	-2.9550	30.6800	0.1170	-0.0037	0.0455
6	-1.9600	30.3900	0.0758	-0.0151	0.0504
7	-0.9530	30.5300	0.0419	-0.0246	0.0548
8	0.0122	30.7300	0.0040	-0.0343	0.0612
9	0.9997	30.5900	-0.0322	-0.0402	0.0664
10	2.0050	30.6000	-0.0734	-0.0451	0.0710
11	3.0230	30.7500	-0.1106	-0.0516	0.0768
12	4.0090	30.7600	-0.1475	-0.0540	0.0840
13	5.0270	30.8700	-0.1829	-0.0569	0.0945
14	6.0170	30.9700	-0.2232	-0.0573	0.1055
15	7.0000	30.7800	-0.2520	-0.0639	0.1252
16	8.0220	30.7500	-0.2893	-0.0808	0.1600
17	9.0120	30.6200	-0.3134	-0.1083	0.2096
18	10.0200	30.5800	-0.3399	-0.1531	0.2906
19	11.0200	30.5500	-0.3563	-0.2017	0.3754
20	12.0200	30.5700	-0.3670	-0.2554	0.4665
21	13.0100	30.1200	-0.3631	-0.3036	0.5426
22	14.0100	30.4500	-0.3683	-0.3531	0.6267
23	6.0170	30.5400	-0.2189	-0.0563	0.1059
24	4.0100	30.9000	-0.1449	-0.0522	0.0851
25	2.0050	30.4000	-0.0647	-0.0458	0.0726
26	0.0122	30.7500	0.0052	-0.0335	0.0619
27	-1.9620	30.7300	0.0821	-0.0144	0.0513
28	-3.9790	30.3600	0.1579	0.0044	0.0436
29	0.0122	0.2240	0.0038	0.0054	0.0014

RUN # 52702 DATA IS STORED IN FILE# 9

TABLE XXXVI

RUN 052701 ON 27 MAY 1977
 PLATE PLUS FAIRING AND WING
 NOMINAL Q= 20 PSF

0

> SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
030	.0122	.1477	.0041	.0038	.0024
031	.0123	20.24	.0118	-.0198	.0430
032	-5.961	20.21	.1608	.0324	.0246
033	-4.963	20.04	.1348	.0211	.0251
034	-3.967	19.91	.1118	.0129	.0252
035	-2.956	19.63	.0833	.0031	.0285
036	-1.961	20.04	.0585	-.0024	.0315
037	-.9538	19.91	.0354	-.0115	.0367
038	.0122	20.10	.0089	-.0205	.0422
039	1.015	19.88	-.0149	-.0286	.0465
040	2.002	20.13	-.0407	-.0342	.0519
041	3.021	20.07	-.0651	-.0389	.0584
042	4.009	20.15	-.0857	-.0442	.0655
043	5.025	20.02	-.1150	-.0461	.0713
044	6.017	20.20	-.1395	-.0503	.0810
045	7.032	19.97	-.1621	-.0550	.0927
046	8.021	20.15	-.1814	-.0675	.1160
047	9.012	20.05	-.2031	-.0906	.1575
048	10.01	19.72	-.2152	-.1229	.2103
049	11.02	19.92	-.2296	-.1559	.2678
050	12.02	19.74	-.2334	-.1913	.3256
051	13.01	19.83	-.2365	-.2282	.3848
052	14.01	19.63	-.2323	-.2573	.4277
053	6.017	20.03	-.1401	-.0477	.0787
054	4.010	20.31	-.0886	-.0422	.0654
055	2.002	19.82	-.0391	-.0323	.0509
056	.0122	20.30	.0068	-.0197	.0425
057	-1.961	20.10	.0669	-.0005	.0301
058	-3.979	19.93	.1154	.0138	.0230
059	.0122	20.08	.0103	-.0200	.0431
060	.0122	.1900	.0043	.0048	.0022

TABLE XXXVII

RUN NO: 52701

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0122	0.1477	0.0041	0.0038	0.0024
2	-5.9610	20.2100	0.1608	0.0324	0.0246
3	-4.9630	20.0400	0.1348	0.0211	0.0251
4	-3.9670	19.9100	0.1118	0.0129	0.0252
5	-2.9560	19.6300	0.0833	0.0031	0.0285
6	-1.9610	20.0400	0.0585	-0.0024	0.0315
7	-0.9538	19.9100	0.0354	-0.0115	0.0367
8	0.0122	20.1000	0.0089	-0.0205	0.0422
9	1.0150	19.8800	-0.0149	-0.0286	0.0465
10	2.0020	20.1300	-0.0407	-0.0342	0.0519
11	3.0210	20.0700	-0.0651	-0.0389	0.0584
12	4.0090	20.1500	-0.0857	-0.0442	0.0655
13	5.0250	20.0200	-0.1150	-0.0461	0.0713
14	6.0170	20.3000	-0.1395	-0.0503	0.0810
15	7.0320	19.9700	-0.1621	-0.0550	0.0927
16	8.0210	20.1500	-0.1814	-0.0675	0.1160
17	9.0120	20.0500	-0.2031	-0.0906	0.1575
18	10.0100	19.7200	-0.2152	-0.1229	0.2103
19	11.0200	19.9200	-0.2296	-0.1559	0.2678
20	12.0200	19.7400	-0.2334	-0.1913	0.3256
21	13.0100	19.6300	-0.2365	-0.2282	0.3848
22	14.0100	19.6300	-0.2323	-0.2573	0.4277
23	6.0170	20.0300	-0.1401	-0.0477	0.0787
24	4.0100	20.3100	-0.0886	-0.0422	0.0654
25	2.0020	19.8200	-0.0391	-0.0323	0.0509
26	0.0122	20.3000	0.0068	-0.0197	0.0425
27	-1.9610	20.1000	0.0669	-0.0005	0.0301
28	-3.9790	19.9300	0.1154	0.0138	0.0230
29	0.0122	0.1900	0.0043	0.0048	0.0022

RUN # 52701 DATA IS STORED IN FILE# 8

TABLE XXXVIII

WEIGHT TARE...PLATE PLUS FAIRING AND WING
27 MAY 1977 AT 1620

W@

> SCAN

#	CH. 0	CH. 1	CH. 2	CH. 3	CH. 4
001	.0124	.1410	.0036	.0025	.0038
002	-5.949	.1404	.0038	.0408	-.0182
003	-4.959	.1383	.0033	.0346	-.0140
004	-3.943	.1418	.0035	.0278	-.0099
005	-2.951	.1419	.0033	.0212	-.0056
006	-1.961	.1438	.0047	.0160	.0006
007	-.9545	.1456	.0042	.0102	.0012
008	.0122	.1435	.0049	.0038	.0039
009	1.016	.1436	.0052	.0012	.0062
010	2.003	.1457	.0047	-.0043	.0111
011	3.022	.1456	.0046	-.0103	.0165
012	4.010	.1467	.0045	-.0171	.0208
013	4.996	.1446	.0046	-.0228	.0245
014	6.017	.1411	.0041	-.0287	.0285
015	7.008	.1443	.0039	-.0352	.0316
016	8.022	.1433	.0045	-.0402	.0364
017	9.028	.1434	.0040	-.0464	.0391
018	10.03	.1456	.0044	-.0517	.0436
019	11.02	.1476	.0042	-.0574	.0476
020	12.01	.1492	.0046	-.0627	.0516
021	13.00	.1485	.0042	-.0682	.0540
022	14.01	.1496	.0044	-.0736	.0578
023	6.017	.1483	.0041	-.0281	.0281
024	4.009	.1484	.0053	-.0166	.0205
025	2.002	.1501	.0045	-.0035	.0111
026	.0122	.1488	.0057	.0045	.0015
027	-1.960	.1543	.0055	.0165	-.0012
028	-3.977	.1552	.0048	.0298	-.0108
029	.0122	.1497	.0050	.0045	.0024

TABLE XXXIX

RUN NO: 52777

ROW #	CH0	CH1	CH2	CH3	CH4
1	0.0124	0.1410	0.0036	0.0025	0.0038
2	-5.9490	0.1404	0.0038	0.0408	-0.0182
3	-4.9590	0.1383	0.0033	0.0346	-0.0140
4	-3.9430	0.1418	0.0035	0.0278	-0.0099
5	-2.9510	0.1419	0.0033	0.0212	-0.0056
6	-1.9610	0.1438	0.0047	0.0160	0.0006
7	-0.9545	0.1456	0.0042	0.0102	0.0012
8	0.0122	0.1435	0.0049	0.0038	0.0039
9	1.0160	0.1436	0.0052	0.0012	0.0062
10	2.0030	0.1457	0.0047	-0.0043	0.0111
11	3.0220	0.1456	0.0046	-0.0103	0.0165
12	4.0100	0.1467	0.0045	-0.0171	0.0200
13	4.9960	0.1446	0.0046	-0.0228	0.0245
14	6.0170	0.1411	0.0041	-0.0287	0.0285
15	7.0080	0.1443	0.0039	-0.0352	0.0316
16	8.0220	0.1433	0.0045	-0.0402	0.0364
17	9.0280	0.1434	0.0040	-0.0464	0.0391
18	10.0300	0.1456	0.0044	-0.0517	0.0436
19	11.0200	0.1476	0.0042	-0.0574	0.0476
20	12.0100	0.1492	0.0046	-0.0627	0.0516
21	13.0000	0.1485	0.0042	-0.0682	0.0540
22	14.0100	0.1496	0.0044	-0.0736	0.0578
23	6.0170	0.1483	0.0041	-0.0281	0.0281
24	4.0090	0.1484	0.0053	-0.0166	0.0205
25	2.0020	0.1501	0.0045	-0.0035	0.0111
26	0.0122	0.1488	0.0057	0.0045	0.0015
27	-1.9600	0.1543	0.0055	0.0165	-0.0012
28	-3.9770	0.1552	0.0048	0.0298	-0.0108
29	0.0122	0.1497	0.0050	0.0045	0.0024

RUN # 52777 DATA IS STORED IN FILE# 7

COMPUTER PROGRAMS

Program A

```

10 CONT M1,DC40,5J
11 REM.....
12 REM "TUNNEL DATA PROCESSING"
13 REM "PROGRAM TO STORE DATA ON TAPE"
14 REM.....
20 DISP "ENTER RUN #";
30 INPUT R1
40 DISP "ENTER # OF DATA ROWS";
50 INPUT J
60 FOR N=1 TO J
70 DISP "ENTER DATA ROW";N;"";
80 INPUT DCN,1J,DLN,2J,DCN,3J,DLN,4J,DCN,5J
90 NEXT N
91 PRINT
92 PRINT "RUN NO: "R1
93 PRINT
95 PRINT "ROW #"TAB10"CH0"TAB20"CH1"TAB30"CH2"TAB40"CH3"TAB50"CH4"
100 FOR N=1 TO J
110 WRITE (15,300)N,DLN,1J,DCN,2J,DLN,3J,DCN,4J,DLN,5J
115 NEXT N
120 DISP "VERIFY DATA, PRESS (CONT-EXEC) ";
125 STOP
130 DISP "INPUT STORAGE FILE #";
140 INPUT Z
150 STORE DATA Z
155 PRINT "RUN #"R1"DATA IS STORED IN FILE#"Z""
300 FORMAT 2X,F3.0,2X,F7.4,3X,F7.4,3X,F7.4,3X,F7.4,3X,F7.4
500 END

```


Program B

```

1  DIM R1,D[40,5]
10 REM *****
11 REM "TUNNEL DATA PROCESSING"
12 REM "PROGRAM TO GENERATE CL,CD,CM-C/4 FOR 3 STRUT MOUNT"
13 REM *****
20 DIM H[3,3],L[3,1],X[40,5],T[40,5],C[40,5],U[100],Y[3,1],V[40,5],W[40,5]
30 WRT READ A
40 DATA -96.154,0,0,0,17.6,25.575,0,-89.065,-66.07
50 C1=0.5
60 S1=1.5
61 DISP "ENTER # OF DATA ROWS";
62 INPUT J
70 DISP "ENTER WIND OFF WT TARE FILE #";
80 INPUT G
90 LOAD DATA G
120 K1=(D[1,3]+D[J,3])/2
130 K2=(D[1,4]+D[J,4])/2
140 K3=(D[1,5]+D[J,5])/2
150 FOR N=2 TO J-1
160 FOR K=1 TO 2
170 T[N-1,K]=D[N,K]
180 NEXT K
190 T[N-1,3]=D[N,3]-K1
200 T[N-1,4]=D[N,4]-K2
210 T[N-1,5]=D[N,5]-K3
220 NEXT N
237 DISP "ENTER Q CAL FOR RUN";
238 INPUT Z
239 DISP "ENTER, RUN FILE #";
240 INPUT G
250 LOAD DATA G

```



```

260 I1=(DL1,2J+DLJ,2J)/2
270 K2=(DL1,3J+DLJ,3J)/2
280 K3=(DL1,4J+DLJ,4J)/2
290 K4=(DL1,5J+DLJ,5J)/2
300 FOR N=2 TO J-1
310 X[N-1,1]=DLH,1J
320 X[N-1,2]=(DLH,2J-K1)*Z/0.1084
330 X[N-1,3]=DLH,3J-K2
340 X[N-1,4]=DLH,4J-K3
350 X[N-1,5]=DLH,5J-K4
360 NEXT N
370 FOR N=1 TO J-2
380 LC1,1J=X[N,3J]-TLH,3J
390 LC2,1J=X[N,4J]-TLH,4J
400 LC3,1J=X[N,5J]-TLH,5J
410 MAT Y=A+L
420 X[N,3J]=YC1,1J/(X[N,2J]*S1)
430 X[N,4J]=YC2,1J/(X[N,2J]*S1)
440 X[N,5J]=YC3,1J/(X[N,2J]*S1+C1)
450 NEXT N
870 PRINT "CORRECTED DATA OF RUN #"

```



```

1000 PRINT "RUN # "TAB8"AOA(DEG)"TAB18"Q(PSP)"TAB30"CL "TAB40"CD"TAB48"CM-C/4"
1010 FOR N=1 TO J-2
1020 WRITE (15,1300)N,D(N,1),D(N,2),D(N,3),D(N,4),D(N,5)
1030 NEXT N
1040 DISP "CHECK DATA,PRESS (CONT-EXEC)";
1050 STOP
1060 DISP "ENTER FILE # FOR REDUCED DATA";
1070 INPUT Z
1080 STORE DATA Z
1090 PRINT "RUN # "R1"REDUCED DATA IS STORED IN FILE # "Z" "
1300 FORMAT 2X,F3.0,1X,F8.4,2X,F8.4,3X,F7.4,3X,F7.4,3X,F7.4
1400 GOTO 237
1410 END

```


Program C

```

1  COM K1,BL40,5]
10 REM .....
11 REM "TUNNEL DATA PROCESSING"
12 REM "PROGRAM TO GENERATE CL,CD,CM-C/4"
13 REM .....
20 DIM AL3,3],LL3,1],XL40,5],TL40,5],UL40,5],VL3,1],VL40,5],WL40,5]
30 MAT READ H
40 DATA -96.154,0,0,0,17.5,25.575,0,-89.065,-66.07
50 C1=0.5
60 S1=1.5
61 DISP "ENTER # OF DATA ROWS";
62 INPUT J
70 DISP "ENTER WD/WG OFF THRE DATA FILE #";
80 INPUT G
90 LOAD DATA G
120 K1=(DL1,3]+DLJ,3])/2
130 K2=(DL1,4]+DLJ,4])/2
140 K3=(DL1,5]+DLJ,5])/2
150 FOR N=2 TO J-1
160 FOR K=1 TO 2
170 TCH-1,K]=DLN,K]
180 NEXT K
190 TCH-1,3]=DLN,3]-K1
200 TCH-1,4]=DLN,4]-K2
210 TCH-1,5]=DLN,5]-K3
220 NEXT H
221 DISP "ENTER WD OFF/WG ON THRE DATA FILE #";
222 INPUT G
223 LOAD DATA G
224 K1=(DL1,3]+DLJ,3])/2
225 K2=(DL1,4]+DLJ,4])/2
226 K3=(DL1,5]+DLJ,5])/2

```



```

227 FOR N=2 TO J-1
228 FOR K=1 TO 2
229 V[N-1,K]=D[N,K]
230 NEXT K
231 V[N-1,3]=D[N,3]-K1
232 V[N-1,4]=D[N,4]-K2
233 V[N-1,5]=D[N,5]-K3
234 NEXT N
237 DISP "ENTER Q CAL OF 05-25-77 FOR RUN";
238 INPUT Z
239 DISP "ENTER NING OFF RUN FILE #";
240 INPUT G
250 LOAD DATA G
260 K1=(D[1,2]+D[J,2])/2
270 K2=(D[1,3]+D[J,3])/2
280 K3=(D[1,4]+D[J,4])/2
290 K4=(D[1,5]+D[J,5])/2
300 FOR N=2 TO J-1
310 X[N-1,1]=D[N,1]
320 X[N-1,2]=(D[N,2]-K1)*Z/0.1084
330 X[N-1,3]=D[N,3]-K2
340 X[N-1,4]=D[N,4]-K3
350 X[N-1,5]=D[N,5]-K4
360 NEXT N
370 FOR N=1 TO J-2
380 L[1,1]=X[N,3]-T[N,3]
390 L[2,1]=X[N,4]-T[N,4]
400 L[3,1]=X[N,5]-T[N,5]
410 MAT Y=A*L
420 X[N,3]=Y[1,1]/(X[N,2]+S1)
430 X[N,4]=Y[2,1]/(X[N,2]+S1)
440 X[N,5]=Y[3,1]/(X[N,2]+S1+C1)
450 NEXT N

```



```

640 DISP "ENTER WING ON RUN FILE #";
650 INPUT G
660 LOAD DATA G
670 K1=(D1,2)+D(J,2))/2
680 K2=(D1,3)+D(J,3))/2
690 K3=(D1,4)+D(J,4))/2
700 K4=(D1,5)+D(J,5))/2
710 FOR N=2 TO J-1
720 C(N-1,1)=D(N,1)
730 C(N-1,2)=(D(N,2)-K1)*2
740 C(N-1,3)=D(N,3)-K2
750 C(N-1,4)=D(N,4)-K3
760 C(N-1,5)=D(N,5)-K4
770 NEXT N
780 FOR N=1 TO J-2
790 LC1,1]=C(N,3)-V(N,3)
800 LC2,1]=C(N,4)-V(N,4)
810 LC3,1]=C(N,5)-V(N,5)
820 MAT Y=A*L
830 C(N,3)=Y(1,1)/(C(N,2)*S1)
840 C(N,4)=Y(2,1)/(C(N,2)*S1)
850 C(N,5)=Y(3,1)/(C(N,2)*S1+C1)
860 NEXT N
870 PRINT "CORRECTED DATA OF RUN # "R1
880 DISP "INPUT WALL CORR'N-DRAW";
890 INPUT B
900 DISP "ENTER WALL CORR'N-AOA";
910 INPUT F
911 DISP "ENTER HEIGHT ABOVE TRUNION (F)";
912 INPUT H

```



```

920 FOR N=1 TO J-2
930 A1=CCN,11/57.3
940 DEN,3)=CCN,31-XCN,31
950 DEN,4)=CCN,41-XCN,41+B*DEN,31+2
960 DEN,5)=CCN,51-XCN,51)+(DEN,31)*H*SIN(A1)+DEN,41)=(1.166-H*COS(A1))/C1
970 DEN,1)=CCN,11+F*DEN,31
980 DEN,2)=CCN,21
990 NEXT N
1000 PRINT "ROW # "TAB8"AOH(DEG)"TAB18"Q(PSF)"TAB38"CL"TAB40"CI"TAB48"CM-C/4"
1010 FOR N=1 TO J-2
1020 WRITE (15,1300)N,DEN,11,DEN,21,DEN,31,DEN,41,DEN,51
1030 NEXT N
1040 DISP "CHECK DATA,PRESS (CONT-EXEC)";
1050 STOP
1060 DISP "ENTER FILE # FOR REDUCED DATA";
1070 INPUT Z
1080 STORE DATA Z
1090 PRINT "RUN # "R1"REDUCED DATA IS STORED IN FILE # "Z" "
1300 FORMAT 2X,F3.0,1X,F8.4,2X,F8.4,3X,F7.4,3X,F7.4,3X,F7.4
1400 GOTO 237
1410 END

```


PROGRAM C(a)

MODIFICATION TO COMPUTE AERODYNAMIC TARES

```

870 PRINT "AERODYNAMIC TARES OF RUH # "R1
880 DISP "INPUT WALL CORR'H-DEAG";
890 INPUT B
900 DISP "ENTER WALL CORR'H-ROA";
910 INPUT F
911 DISP "ENTER HEIGHT ABOVE TRUNNION (FT)";
912 INPUT H
920 FOR N=1 TO J-2
930 A1=CLN,1)/57.3
940 DLN,3)=CLN,3]-XCH,3]
941 WLN,3]=-XLN,3]
950 DLN,4)=(CLN,4]-XLN,4])+B*DLH,3]+2
951 WLN,4]=-XLN,4]
960 DLN,5)=(CLN,5]-XLN,5])+(DLN,3)*H*SIN(H1)+DLN,4]*(1.166-H*COS(H1)))/C1
961 WLN,5]=-XLN,5]
970 DLN,1)=CLN,1]+F*DLH,3]
980 DLN,2)=CLN,2]
990 NEXT N
1000 PRINT "ROW # "TAB8"AOA(DEG)"TAB18"Q(PSF)"TAB29"DCL"TAB39"DCD"TAB47"DCM-C/4"
1010 FOR N=1 TO J-2
1020 WRITE (15,1300)N,DLN,1],DLN,2],WLN,3],WLN,4],WLN,5]
1030 NEXT N
1040 DISP "CHECK DATA,PRESS (CONT-EXEC)";
1050 STOP
1060 DISP "ENTER FILE # FOR REDUCED DATA";
1070 INPUT Z
1080 STORE DATA Z
1090 PRINT "RUN # "R1"REDUCED HERO TARES ARE STORED IN FILE # "Z" "
1090 FORMAT 2X,F3.0,1X,F8.4,2X,F8.4,3X,F7.4,3X,F7.4,3X,F7.4
1400 GOTO 237
1410 END

```


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